NorthMet Project

DRAFT Environmental Impact Statement

October 2009

VOLUME I: TEXT AND TABLES

Carrol Henderson

Minnesota Department of Natural Resources

US Army Corps of Engineers
St. Paul District

COVER SHEET

Draft Environmental Impact Statement
NorthMet Project
PolyMet Mining, Inc.

The Minnesota Department of Natural Resources and the U.S. Army Corps of Engineers have jointly prepared the Draft Environmental Impact Statement (DEIS) to evaluate the proposed project in accordance with the National Environmental Policy Act 42 USC 4321-4347, and the Minnesota Environmental Policy Act, *Minnesota Statutes*, section 116D.

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Abstract: This Draft Environmental Impact Statement documents the analysis of potential impacts associated with the PolyMet Mining, Inc. proposed NorthMet Project. The proposed project includes open pit mining operations with ore hauled to the processing facility on a largely existing rail line owned by PolyMet. Waste rock, lean ore, and deferred ore stockpiles from the mining operations are proposed to be located near the mine pits. Stockpiles would be managed based on the reactivity of the rock and overburden materials. Stockpiles are proposed to include liner systems to capture water passing through the material and cover systems to limit water infiltration into the material after closure and reclamation. Liner and cover system designs are based on the degree of predicted heavy metal leaching expected from each material's classification type. Ore would be processed at a refurbished and modified taconite processing facility (formerly the LTV Steel Mining Company Erie Plant). 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, gold, and flotation concentrations. Precipitates and flotation concentrates are proposed for shipment off-site for third party processing. 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 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.

Approved for Issuance for Public Comment:

10/27/09
Date

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10/27/09
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for Karl Ongaro A
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DEFINITIONS

Acid Rock Drainage: A water solution of low pH and elevated dissolved constituents, formed from the natural and / or mining-enhanced interaction of sulfide minerals with oxygen (air), water, and in some circumstances, bacteria. Also known as "Acid Mine Drainage."

Air dispersion model: A computer program that incorporates a series of mathematical equations used to predict downwind concentrations in the ambient air resulting from emissions of a pollutant. Inputs to a dispersion model include the emission rate; characteristics of the emission release such as stack height, exhaust temperature, and flow rate; and atmospheric dispersion parameters such as wind speed and direction, air temperature, atmospheric stability, and height of the mixed layer.

Air quality: The cleanliness of the air as measured by the levels of pollutants relative to standards of guideline levels established to protect human health and welfare. Air quality is often expressed in terms of the pollutant for which concentrations are the highest percentage of a standard (e.g., air quality may be unacceptable if the level of one pollutant is 150% of its standard, even if levels of other pollutants are well below their respective standards).

Area of Potential Effect: the geographic region that may be impacted as a result of the construction and operation of the Proposed Action or alternatives.

Aquifer: A subsurface saturated rock unit (formation, group of formation, or part of a formation) of sufficient permeability to transmit groundwater and yield usable quantities of water to wells and springs.

Attainment: Air quality in the locality that meets the established standards.

Autoclave: A vessel for conducting chemical reactions under high pressure.

Bedrock: The rock of Earth's crust that is below the soil and largely unweathered.

Berm: A mound or wall of earth.

Blowdown: The portion of a stream or water removed from a boiler at regular intervals to prevent excessive accumulation of dissolved and suspended materials.

Class I area: Under the Clean Air Act, a Class I area is one in which visibility is protected more stringently than under the national ambient air quality standards, with only a small increase in pollution allowed. Class I areas include national parks, wilderness areas, monuments, and other areas of special national and cultural significance.

Class II area: Under the Clean Air Act, Class II areas are all other clean air regions not designated Class I areas, with moderate pollution increases allowed.

Contaminant: A substance that contaminates (pollutes) air, soil, or water. It may also be a hazardous substance that does not occur naturally or that occurs at levels greater than those that occur naturally in the surrounding environment.

Contamination: The intrusion of undesirable elements (unwanted physical, chemical, biological, or radiological substances; or matter that has an adverse effect) to air, water, or land.

Cooling water: Water that is heated as a result of being used to cool steam and condense it to water.

Decibel: A unit for expressing the relative intensity of sounds on a logarithmic scale from zero for the average least perceptible sound to about 130 for the average level at which sound causes pain to humans.

dB(A): Decibels as measured on the A-weighted scale (dB(A))

Dike: (1) An embankment for controlling or holding back waters; (2) A bank of earth formed of material being excavated.

Endangered species: A species that is in danger of extinction throughout all or a significant part of its range; a formal listing of the U.S. Fish and Wildlife Service under the Endangered Species Act.

Environmental Justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Executive Order 12898 directs Federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.

Evapotranspiration: The amount of water removed from a land area by the combination of direct evaporation and plant transpiration.

Fill material: Material used for the primary purpose of replacing an aquatic or wetland area with dry land, or changing the bottom elevation of a waterway.

Fugitive dust: Particulate matter composed of soil; can include emissions from haul roads, wind erosion or exposed surfaces, and other activities in which soil is removed and redistributed.

Fugitive emissions: Emissions releases directly into the atmosphere that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

Glacial till: Direct glacial deposits that are unsorted and unstratified.

Hazardous Air Pollutant: Air pollutants that are not covered by ambient air quality standards, but may present a threat of adverse human health effects or adverse environmental effects, and are specifically listed on the Federal list of 189 hazardous air pollutants in 40 CFR 61.01

Hazardous waste: A category of waste regulated under RCRA.To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20 through 40 CFR 261. 24 (i.e., ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the EPA in 40 CFR 261.31 through 40 CFR 261.33.

Hydrology: (1) The study of water characteristics, especially the movement of water; (2) The study of water, involving aspects of geology, oceanography, and meteorology.

Hydrometallurgical: Pertaining to hydrometallurgy; involving the use of liquid reagents in the treatment or reduction of ores.

Integrated Gasification Combined Cycle: A process that uses synthetic gas derived from coal to drive a gas combustion turbine and exhaust gas from the gas turbine to generate steam from water to drive a steam turbine.

Infiltration: The process of water entering the soil at the ground surface and the ensuing movement downward. Infiltration becomes percolation when water has moved below the depth at which it can return to the atmosphere by evaporation or evapotranspiration.

L_{10}: Sound levels not to be exceeded for 10% of the time

L_{50}: Sound levels not to be exceeded for 50% of the time

L_{dn}: Day-night average sound level

Laydown area: Material and equipment storage area during the construction phase of a project.

Leachate: Solution of product obtained by leaching, in which a substance if dissolved by the action of a percolating liquid.

Noise: Any sound that is undesirable because it interferes with speech and hearing; if intense enough, it can damage hearing.

New Source Performance Standard: Regulation under Section 111 of the Clean Air Act enforcing stringent emission standards for power plants constructed on or after January 30, 2004.

Overburden: Waste earth and rock covering a mineral deposit.

pH: A measure of relative acidity or alkalinity of a solution, expressed on a scale from 0 to 14, with the neutral point at 7. Acid solutions have pH values lower than 7, and basic (alkaline) solutions have pH values higher than 7.

Particulate matter: Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions.

Riparian: Of, on, or pertaining to the bank of a river or stream, or of a pond or small lake.

Sludge: A semi-solid residue containing a mixture of solid waste material and water from air or water treatment processes.

Slurry: A watery mixture or suspension of fine solids, not thick enough to consolidate as sludge.

Subaqueous: Existing or situated under water.

Taconite: A low-grade iron ore, containing about 27% silica and 51% silica; found as a hard rock formation in the Lake Superior region.

Tailings Basin: An on-site water-filled enclosure that receives discharges of wastewater containing solid residues from processing of minerals. The solid residues settle due to gravity and separate from the water.

Threatened species: A species that is likely to become an endangered species within the foreseeable future throughout all or a significant part of its range.

Till: Glacial drift consisting of an unsorted mixture of clay, sand, gravel, and boulders.

Ton: A unit of measurement equivalent to 2,000 pounds.

Water table: (1) The upper limit of the saturated zone (the portion of the ground wholly saturated with water); (2) The upper surface of a zone of saturation above which the majority of pore spaces and fractures are less than 100 percent saturated with water most of the time (unsaturated zone) and below which the opposite is true (saturated zone).

Wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence or vegetation typically adapted for life in the saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

NORTHMET PROJECT DRAFT ENVIRONMENTAL IMPACT STATEMENT – SUMMARY COPY

I. INTRODUCTION

This Draft Environmental Impact Statement Summary (Summary DEIS) contains an overview of the NorthMet Project and the regulatory framework for the preparation of the DEIS. It presents in summary form the Proposed Action, Project alternatives, major findings, and areas of controversy regarding significant impacts.

The DEIS provides a more thorough discussion of the Project, background data, major findings, Project alternatives, and a detailed description of the differing opinions regarding significant impacts.

I.A BACKGROUND AND LOCATION OF THE NORTHMET PROJECT

The Minnesota Department of Natural Resources (MnDNR) and the U.S. Army Corps of Engineers (USACE) have prepared a joint state and federal DEIS to analyze the potential environmental consequences of the proposed NorthMet Mine and Ore Processing Facilities Project (NorthMet Project or Project). PolyMet Mining, Inc (PolyMet) proposes to construct and operate an open pit mine and processing facility to process low-grade disseminated sulfide-bearing ore into finished copper metal and various copper, nickel, cobalt, and precious metal concentrates and precipitates.

The proposed Project, including the Mine Site, Plant Site, and connecting infrastructure, would be located on the south flank of the Mesabi Iron Range in St. Louis County, Minnesota (Figure S-1). The Mine Site would be located at a previously unmined area in the Superior National Forest approximately six miles south of the City of Babbitt. The Plant Site would be approximately six miles north of the City of Hoyt Lakes at a currently inactive taconite processing facility.

The Mine Site is located on National Forest System lands; however, the mineral rights are privately held and under lease to PolyMet. It is the position of the United States that the mineral rights leased by PolyMet do not include the right to open pit mine the National Forest System land. PolyMet disagrees with the U.S. Forest Service (USFS) interpretation of the deed language and argues that the mineral rights it seeks to utilize provide for access to the minerals by any mining method including open pit or surface mining.

The USFS and PolyMet are exploring the feasibility of a land exchange to consolidate the surface ownership and mineral rights to PolyMet and thereby remove all National Forest System lands from the proposed Project. The USFS will be initiating its own EIS to evaluate the proposed land exchange, while this NorthMet Project DEIS assumes the successful completion of a land exchange.

The Plant Site would be located at the former LTV Steel Mining Company (LTVSMC) taconite processing facility, which would be refurbished and modified to include a beneficiation plant and a hydrometallurgical plant.

I.B PROJECT PURPOSE AND NEED

The purpose and need of the proposed Project is to produce base and precious metal, precipitates, and flotation concentrates from ore mined at the NorthMet deposit by uninterrupted operation of the former LTVSMC processing plant site. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.

I.C REGULATORY FRAMEWORK

The proposed Project is subject to both federal and state regulations to protect human health and the environment. The DEIS evaluates the proposed Project in accordance with the National Environmental Policy Act (NEPA) and the Minnesota Environmental Policy Act (MEPA).

NEPA requires that federal agencies consider the potential environmental consequences of proposed actions in their decision-making process and mandates that the lead federal agency must prepare a “detailed statement for legislation and other major federal actions significantly affecting the quality of the human environment.” Such actions include projects subject to federal permits. The USACE, during its review of PolyMet’s Section 404 Individual Permit application, determined that the proposed Project would require preparation of an EIS.

The MEPA environmental review process is a decision-making tool for the Minnesota permitting and approval processes and to describe available mitigation measures. The state body responsible for the review is the Responsible Governmental Unit (RGU). The MnDNR is the RGU for the proposed Project and determined an EIS shall be prepared because the proposed Project exceeds the threshold for construction of a new metallic mineral mining and processing facility (*Minnesota Rules*, part 4410.4400, subpart 8).

In addition, the proposed Project may require the following federal, state, and local permits or approvals:

Federal Agencies
USACE
- Section 404 Individual Permit
- National Historic Preservation Act Consultation

U.S. Fish and Wildlife Service
- Endangered Species Act Consultation

USFS
- Land exchange to resolve split estate

State Agencies
MnDNR
- Permit to Mine
- Endangered Species Taking Permit
- Water Appropriations Permit
- Dam Safety Permit
- Permit for Work in Public Waters
- Wetland Replacement Plan
- Burning Permit

Minnesota Pollution Control Agency

- Section 401 Water Quality Certification/Waiver
- National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit(s)
- Solid Waste Permit
- Air Emissions (Part 70) Permit
- Waste Tire Storage Permit
- General Storage Tank Permit

Minnesota Department of Health

- Radioactive Material Registration
- Non-Community Public Water Supply System Permit and Wellhead Protection Plan
- Public On-site Sewage Disposal System Permit

Local Permits

City of Hoyt Lakes

- Zoning Permit

City of Babbitt

- Building Permit

St. Louis County

- Zoning Permit

I.D AGENCY ROLES AND RESPONSIBILITIES

The MnDNR and USACE are serving as co-lead agencies in preparation of this DEIS, with MnDNR serving as the RGU under MEPA and the USACE serving as the lead federal agency under NEPA. The Mine Site for the Project is currently located on National Forest System lands; therefore, the USFS is participating as a cooperating agency as it is the current federal land manager. The Mine and Plant Sites are also located within the 1854 Treaty Ceded Territory where the Bois Forte Band of Chippewa, Fond du Lac Band of Lake Superior Chippewa, and Grand Portage Band of Chippewa retain hunting, fishing, and gathering rights under the Treaty of 1854. For this reason, the Bois Forte Band and Fond du Lac Band are also participating as cooperating agencies. A memorandum of understanding (last amended in May 2008) defines the roles and responsibilities of these parties. The Grand Portage Band is not currently a cooperating agency or signatory to the memorandum of understanding; however, they have been involved in the DEIS preparation process and recently requested formal confirmation of cooperating agency status for the Project.

The Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) are assisting the MnDNR, but are not party to the memorandum of understanding.

The U.S. Environmental Protection Agency (USEPA) has an oversight role over the NEPA process and has participated in the review of draft documents leading up to the DEIS.

II. SCOPING PROCESS

II.A SUMMARY OF THE SCOPING PROCESS

The federal and state scoping efforts were conducted jointly, led by MnDNR, following the process outlined by *Minnesota Rules*, part 4410.2100 to define a reasonable scope for the EIS. The 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 EAW and Draft SDD provided information about the proposed Project, identified potentially significant environmental effects, and determined what issues and alternatives will be addressed in the EIS and the required level of analysis. Key dates in the scoping process were:

- May 10, 2005: USACE issued the Section 404 Permit Public Notice.
- June 6, 2005: MnDNR, with USACE and USFS, issued the Scoping EAW and Draft SDD for a 30-day comment period.
- June 29, 2005: Public Meeting in Hoyt Lakes.
- July 1, 2005: USACE issued the Notice of Intent to Prepare an EIS.

The comments received during the scoping process were considered by the MnDNR and the USACE prior to the issuance of the Final SDD on October 25, 2005. The scoping process ended and DEIS preparation began upon the publication of a DEIS preparation notice in the Minnesota Environmental Quality Board (EQB) Monitor on April 24, 2006.

II.B ISSUES IDENTIFIED DURING THE EIS SCOPING PROCESS

Based on the results of the scoping process defined above, the DEIS considered the potential environmental impacts of the proposed Project on the following 12 resources:

- Water Resources
- Wetlands
- Vegetation
- Wildlife
- Fish and Macroinvertebrates
- Air Quality
- Noise
- Cultural Resources
- Compatibility with Land Use Plans and Regulations
- Socioeconomics
- Visual Resources
- Hazardous Materials

Subsequent to scoping, geotechnical stability and integrated cumulative effects analyses were added to the DEIS in response to federal, state, and tribal cooperating and consulting agency comments.

II.C CUMULATIVE EFFECTS CONSIDERED IN THE DEIS

The DEIS also addresses the potential cumulative effects associated with the combined resource-level environmental effects of the proposed Project with 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, and visibility impairment;

- Biological Resources - loss of wetlands, loss of threatened and endangered plant species, loss or fragmentation of wildlife habitat, and mercury deposition and bioaccumulation in fish;
- Water Quality – streamflow, lake level, and water quality changes;
- Economic Impacts; and
- Social Impacts.

III. NORTHMET PROJECT

III.A INTRODUCTION

The NorthMet Project proposes the surface mining and mineral processing of approximately 228 million tons of Copper-Nickel-Platinum Group Element (PGE) ore over an approximately 20-year mine life. The Project would develop a new surface mine and reactivate/develop portions of the existing Processing Plant and Tailings Basin at the former LTVSMC site. To accomplish this, PolyMet proposes to:

- Open-pit mine an average of approximately 91,200 tons per day (tpd) of rock, including up to 32,000 tpd of ore from a surface mine with three pits (i.e., East, Central, and West Pits).
- Generate approximately 394 million tons of waste rock and lean ore over the life of the mine.
- Transport the ore to the proposed processing plant via 100-ton side-dumping train cars.
- Process the ore through beneficiation and hydrometallurgical plants.
- Construct and operate a Tailings Basin and hydrometallurgical residue facility to dispose of flotation tailings from the beneficiation plant and residues from the hydrometallurgical plant, respectively.
- Close and reclaim the Project components including vegetative and watershed restoration of the waste rock stockpiles and Tailings Basin, building and infrastructure demolition, and post-closure monitoring and maintenance of the closure activities.

For the purposes of the DEIS, the proposed Project consists of the following major components (Figure S-2):

- Mine Site – the mine pits, stockpiles, lean ore surge pile, overburden storage and laydown area, waste water treatment facility (WWTF), and central pumping station (CPS);
- Plant Site – the Processing Plant, Tailings Basin, Area 1 and 2 Shops, Main Gate, and the railroad connection; and
- Transportation Corridor – the Dunka Road segment, railroad segment, the pipelines and transmission lines between the Mine Site and the Plant Site, and the pipeline between the Plant Site and Colby Lake.

An approximately five-mile radius around these major components is identified in the DEIS as the Project area and generally served as the basis for the impact evaluation.

The major elements and potential effects of the Proposed Action as well as two action alternatives (i.e., the Mine Site Alternative and Tailings Basin Alternative) and the No Action Alternative are evaluated in the DEIS and are discussed individually in the following sections.

III.B PROPOSED ACTION

The Proposed Action is described in the January 2007 revised Project Description (updated in July 2007) and supporting documents submitted by PolyMet between 2006 and 2009.

III.B.1 Proposed Action Description

The specific elements of the Proposed Action at the Mine Site, Plant Site, and during Project Closure are discussed below.

Mine Site

The proposed Project would develop three separate open mine pits (East, Central, and West pits) with the East and Central pits combined into one large pit (East Pit) by Year 13. The ore, waste rock, and overburden would be transported within the Mine Site along a series of haul roads and the extracted ore would be transported to the Plant Site via railroad.

The waste rock from the mine pits would be sorted into four categories from least reactive (Category 1) to most reactive (Category 4) according to its geochemical, acid-producing, and metal-leaching properties. Category 3 and Category 4 lean ore would also be separated. Lean ore cannot be economically processed at the time of mining, but could be in the foreseeable future. The rock would be hauled to the following waste rock stockpiles at the Mine Site:

- Category 1 and 2 Waste Rock Stockpile;
- Category 3 Waste Rock Stockpile;
- Category 3 Lean Ore Stockpile;
- Category 4 Waste Rock Stockpile; or
- Category 4 lean ore would be hauled to the Lean Ore Surge Pile or the Rail Transfer Hopper.

Once mining of the East Pit is completed, some of the Category 1 and 2 waste rock would be used to fill in the East Pit and thereby stored subaqueously; however, the majority of the waste rock stockpiles would be permanent surface features with liner and cover systems to prevent metals from leaching to the surrounding landscape.

The mine pit surface overburden would be sorted into organic soils (peat), unsaturated overburden, and saturated overburden. The peat and unsaturated overburden would be stockpiled in the Overburden Storage and Laydown Area and the remaining material would be placed in the Category 1 and 2 Waste Rock Stockpile.

A series of dikes and ditches would capture and convey most of the surface runoff and process water to the WWTF by the CPS. This treated water would then be pumped to the Plant Site Tailings Basin for use as processing makeup water or used to backfill the East Pit once mining is completed. The Mine Site features are shown in Figure S-3.

Plant Site

The proposed Project would produce the copper concentrates and metallic precipitates at the former LTVSMC Processing Plant. The existing infrastructure at the Plant Site includes roads, railroads, electrical transmission lines, sanitary and potable water treatment facilities, and the beneficiation plant. The hydrometallurgical plant would be constructed during the mine development.

Beginning in the beneficiation plant, the bulk ore would be ground into a slurry and transferred to the flotation area where the base and precious metal sulfide minerals would be chemically separated from the non-metallic waste (tailings), cleaned, and sent to the hydrometallurgical plant. The tailings would be transferred as a slurry to Cell 2E in the Tailings Basin north of the Processing Plant (and expand into Cell 1E over the life of the Project). The slurry solids would settle over time within the Tailings Basin pond and the pond water would be reused in the beneficiation plant. Prior to the completion of the hydrometallurgical plant, or during routine maintenance periods, the beneficiation plant would operate in a "concentrate only" mode. In this mode, the bulk copper/nickel concentrates would be separated for resale.

The hydrometallurgical process would separate the PGE, precious metals, and base metals from the beneficiation concentrates. Copper metal would be produced using solvent extraction and electrowinning processes; nickel, cobalt, and precious metals would be refined into metal concentrates and sent offsite for final processing. The hydrometallurgical wastes (residues) would be transferred to the hydrometallurgical residue cells, a series of four lined cells in the southwest corner of Cell 2W. The Plant Site features are shown in Figure S-4.

Closure

In general, Project facilities would be progressively reclaimed during the life of the Project such that only a portion would need to be reclaimed at Closure. The general components of the Project Closure Plan are:

<u>Mine Site</u>

- Demolition and reclamation of the mine pit and Mine Site infrastructure, including the waste rock stockpiles.
- Wetland creation in the East Pit and West Pit outflow (partially as passive treatment systems). The West Pit overflow would ultimately be directed to the Partridge River.
- Collection and treatment of drainage from the waste rock stockpiles until water quality discharge limits are met.
- Reconfiguration of the dike and ditch system to convey runoff to the mine pits and restore natural flow paths.
- Construction of a gated entrance and perimeter fence.
- Inspection, maintenance, and reporting as required by the MPCA and the MnDNR.

<u>Plant Site</u>

- Demolition and reclamation of Plant Site infrastructure.
- Maintenance and construction of surface water and groundwater controls in the Tailings Basin, including emergency channels and/or outfall structures for extreme precipitation events.
- Bentonite augmentation of the surface pond and wetland creation in the Tailings Basin.

- Inspection, maintenance, and reporting as required by the MPCA and the MnDNR.

III.B.2 Impacts of the Proposed Action

The DEIS considered the impacts of the proposed Project on 14 resources (see Section II.B) and determined that the proposed Project would have no effect or negligible effects related to noise, compatibility with plans and land use regulations, visual resources, and hazardous materials. The potential effects of the Proposed Action on the remaining ten resources are summarized below. Section III.G of this summary describes Native American tribal cooperating agency differences of opinion with the MnDNR and USACE conclusions. These differences are also presented within the full DEIS.

Water Resources

- Groundwater levels at the Mine Site – Drawdown expected during mine operations and filling of the West Pit until Year 65.
- Mine Site Groundwater Quality – Antimony, manganese, and nickel predicted to exceed USEPA primary Maximum Contaminant Levels (MCLs) or MDH Health Risk Limits, potentially for the long term at the Mine Site. Sulfate would exceed the groundwater evaluation criteria of 250 mg/L.
- Flows in the Upper Partridge River - Reduce average flow by approximately 1.5 cubic foot per second (cfs). Minimal absolute reduction in annual 7-day low flow (~0.1 cfs, or about 22%). No significant effect on river morphology or 100-year floodplain.
- Water Quality in the Upper Partridge River - All parameters predicted to meet all surface water quality standards at all locations during all flow conditions for all mine years. West Pit overflow in Closure is predicted to initially exceed standards for such parameters, but water quality is expected to improve over time and exceedances could be mitigated.
- Water levels in Colby Lake and Whitewater Reservoir - Negligible increase (0.03 ft) in average water level drawdown and improvement in maximum annual fluctuation and percentage days below critical elevation in Colby Lake. Water level fluctuations and average drawdown would increase at Whitewater Reservoir relative to existing conditions, but would be no greater than when LTVSMC was operating.
- Water Quality in Colby Lake – All parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.
- Flows in the Lower Partridge River – Reduce average flows by as much 10.5 cfs (9%) and increase the frequency, but not the magnitude of low flows.
- Water Quality in the Lower Partridge River - All parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.
- Groundwater Levels Downgradient of the Tailings Basin – Groundwater seepage would exceed aquifer flux capacity resulting in significant seepage upwelling and wetland impacts.
- Groundwater Quality Downgradient of the Tailings Basin – Groundwater seepage from the Tailings Basin would generally meet groundwater evaluation criteria with the exception of aluminum. Aluminum would exceed the USEPA secondary MCL standard for managing

aesthetic considerations (not to protect human health), and is naturally found in elevated concentrations in the Project area.

- Flows in the Embarrass River - Net 6% increase in average flow during operations and net 1% decrease during Closure would have a negligible effect on flows in the Embarrass River.
- Water Quality in the Embarrass River – All parameters predicted to meet surface water quality standards during all flow conditions for all mine years.
- Waters that Contain Wild Rice - Increase in hydrologic variability and a 1 to 2 mg/L increase in sulfate concentrations in the Lower Partridge River, although sulfate concentrations are already elevated in this area (>100 mg/L). Negligible effect on seasonal hydrology of the Embarrass River, but an increase in sulfate concentrations under average flows of 20 mg/L predicted at PM-13, although sulfate concentrations are already somewhat elevated in this area (33 mg/L).
- Mercury in Water - Relatively high sulfate concentrations in seepage from the Tailings Basin would be released to wetlands north of the Tailings Basin and lakes downstream on the 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, but this impact could be mitigated if it would occur.

In some cases there was a high degree of uncertainty regarding key input assumptions to the deterministic models for the West Pit flooding and water quality, groundwater quality downgradient of the Tailings Basin, waste rock stockpiles, and Partridge River surface water quality. In these cases, the DEIS used a probabilistic simulation, or Uncertainty Analysis, to assess whether the deterministic modeling produced conservative values for the release of selected contaminants. The Uncertainty Analysis used probability to estimate a range of predicted water quality values, as opposed to the single value predictions from the deterministic simulations. The Uncertainty Analysis simulated 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 and are discussed further in the DEIS.

The Uncertainty Analysis generally confirmed the results of the deterministic modeling; however, in some cases the results conflicted, which makes it difficult to draw firm conclusions regarding groundwater quality. Although the conservatism of some of the Uncertainty Analysis assumptions can be argued, it is clear that the Proposed Action would exceed groundwater evaluation criteria at the Mine Site for at least several parameters.

Wetlands

- Direct impacts to 804.3 acres at the Mine Site, 39.4 acres at the Plant Site and 10.5 acres along the transportation corridor, primarily consisting of coniferous and open bogs.
- Indirect impacts to 318.6 acres at the Mine Site and 349.3 acres at the Plant Site due to wetland fragmentation, noise, dust, and hydrologic effects.

Vegetation

- Loss of 269 acres of vegetative cover at the Plant Site and 1,454 acres of vegetative cover at the Mine Site.
- Revegetation would introduce non-native, invasive species.
- Direct impacts to the following endangered, threatened, or special concern (ETSC) species: prairie moonwort (*Botrychium campestre*), pale moonwort (*B. pallidum*), least grapefern (*B. simplex*), neat spikerush, *(Eleocharis nitida*), lapland buttercup (*Rununculus lapponicus*), clustered bur-reed (*Spartinum glomeratum*), and Torrey's manna-grass (*Torreyochloa pallida*).
- Indirect impacts to pale moonwort, ternate grapefern (*B. regulosum*), least grapefern, floating marsh mallow (*Caltha natans*), neat spikerush, lapland buttercup, and clustered bur-reed due to changes in hydrology or other surface conditions.

Wildlife

- Overall loss of wildlife habitat including a potential loss of critical habitat for the Canada lynx and gray wolf (federally-listed species) and increased risk of vehicle strikes to Canada lynx and gray wolf at the Mine Site. No anticipated effects to other ETSC wildlife species.

Fish and Macroinvertebrates

- Increased duration and frequency of low flows on the Lower Partridge River could degrade aquatic habitat.
- Potential to increase methylmercury availability to fish. Discharge of sulfates from the Tailings Basin could increase methylmercury production in downgradient wetlands and the downstream Embarrass River chain of lakes.

Air Quality

- Project facilities and operations would result in additional greenhouse gas (GHG) emissions in the Arrowhead region.

Cultural Resources

- Adverse effects from the demolition of the Concentrator Building and facility railroad spur at the Plant Site, both of which are eligible for inclusion on the National Register of Historic Places. The Building and railroad spur would be documented in accordance with the Minnesota Historic Preservation Office procedures prior to demolition.
- Potential loss of access to public lands for tribal use due to the land exchange; however PolyMet intends to propose private lands within the 1854 Ceded Territory for exchange.

Socioeconomics

- Beneficial effect through a local increase in employment, tax revenues, and spending.

Geotechnical Stability

- The NorthMet Tailings Basin and hydrometallurgical residue facility embankments would have a low margin of safety due to fines and underlying soils in the existing LTVSMC Tailings Basin.

Cumulative Effects

- General increase in air emissions; however, no significant effect on regional air quality. Cumulative increase in emission of CO_2 and other greenhouse gases (GHGs).
- Minimal effects on the hydrology of the St. Louis River Basin.
- Minimal effects on overall water quality in the St. Louis River Basin due to increased concentrations of metals and other water quality parameters; however, concentrations would remain below surface water standards.
- Cumulative increase in sulfate loadings to the Partridge, Embarrass, and St. Louis River.
- Cumulative loss of wildlife habitat and migration routes throughout the Iron Range.
- Overall Tribal loss of access to lands and natural resources within the 1854 Ceded Territory.

III.C MINE SITE ALTERNATIVE

The Mine Site Alternative consists of a modified design or layout to reduce the Proposed Action's potential impacts to surface and ground water quality at the Mine Site. This alternative only applies to the Mine Site and no changes would be made to the Plant Site or the transportation corridor relative to the Proposed Action.

III.C.1 Mine Site Alternative Description

The fundamental difference in this alternative relative to the Proposed Action is the long-term treatment and disposal of the waste rock at the Mine Site. This alternative would subaqueously dispose of the most-reactive waste rock (Category 2, 3 and 4) in the East Pit while the least reactive waste rock (Category 1 and overburden) would remain as a permanent surface stockpile. The backfilling design capacity of the East Pit would be 125 million tons. Therefore, the pit can accommodate all the Category 2, 3, and 4 waste rock (<100 million tons). Since Category 2, 3, and 4 waste rock is more reactive, it may be preferable to dispose of this rock subaqueously to prevent oxidation.

The Category 2, 3, and 4 waste rock would be stored in temporary surface stockpiles until mining of the East Pit is completed (Year 11) and it becomes available for subaqueous waste rock disposal. The temporary surface stockpiles would be constructed with the same liner and cover systems and located within the footprint of the permanent Category 3 and 4 surface stockpiles described under the Proposed Action. Limestone or lime may be added to the temporary stockpiles to neutralize acid formation. Once the East Pit is mined out, the Category 2, 3, and 4 waste rock would be placed into the pit and the temporary Category 3 Waste Rock Stockpile would be converted to a permanent Category 1 Waste Rock Stockpile. The Category 4 Waste Rock Stockpile would be permanently eliminated.

The Category 4 lean ore would be processed as it is mined, while the Category 3 lean ore would be temporarily stockpiled to determine whether current market conditions dictate it should be processed or disposed in the East Pit as waste rock. The temporary lean ore stockpiles would be located as described under the Proposed Action.

III.C.2 Impacts of the Mine Site Alternative

The Mine Site Alternative would have similar effects on all resources at the Mine Site as the Proposed Action; however, the subaqueous disposal of the most-reactive waste rock would affect the following resources at the Mine Site relative to the Proposed Action:

Water Resources

- Groundwater Quality at the Mine Site – Antimony (only) may exceed USEPA primary MCL and MDH Health Risk Limits.

It is clear that, relative to the Proposed Action, the Mine Site Alternative would ultimately result in reduced surface water and groundwater quality impacts in the Partridge River watershed for most parameters.

Wetlands

- Elimination of the permanent Category 4 Waste Rock Stockpile and Lean Ore Surge Pile would reduce direct wetland impacts at the Mine Site by 7.6 acres. No change to the indirect wetland effects.

Vegetation

- Elimination of the permanent Category 4 Waste Rock Stockpile and Lean Ore Surge Pile would reduce permanent vegetative cover impacts at the Mine Site by 33 acres.

Wildlife

- Elimination of the permanent Category 4 Waste Rock Stockpile and Lean Ore Surge Pile would reduce permanent wildlife habitat impacts at the Mine Site by 33 acres.

Fish and Macroinvertebrates

- Surface water quality in the Partridge River watershed would experience less impact relative to the Proposed Action.

Air Quality

- Additional transport of the waste rock for subaqueous disposal in the East Pit would increase transportation emissions relative to the Proposed Action; however, this alternative would still comply with all ambient air quality standards.

III.D TAILINGS BASIN ALTERNATIVE

The Tailings Basin Alternative consists of a modified design or layout to reduce the Proposed Action's potential impacts to surface and ground water quality at the Tailings Basin. This alternative is the combination of several potentially viable individual mitigation measures and resulted from the comprehensive mitigation planning efforts of the participating federal, state, and tribal agencies.

Under this alternative, no changes would be made to the Mine Site or the transportation corridor relative to the Proposed Action.

III.D.1 Tailings Basin Alternative Description

The fundamental difference of this alternative relative to the Proposed Action is the management of seepage and geotechnical stability in the Tailings Basin. The basic components of this Alternative are as follows:

- Prior to NorthMet operations, ground water pumping wells would be installed on the northern embankment of the Tailings Basin to capture seepage. There are two options for water management. The "Maximum Recycle Option" would return nearly the maximum amount of reusable seepage as make up water at the Plant Site and discharge the remaining seepage to the Partridge River. The "No Recycle Option" would pump all the seepage directly to the Partridge River. The discharge point for both options is downstream of the Colby Lake Outlet Structure. During Closure, the water would discharge directly to the Partridge River until water quantity, water quality, passive treatment, or other conditions indicate that collection of seepage is no longer needed.
- During Closure, a partial dry cap of either bentonite clay-amended or geomembrane plastic would be installed over the crest of the perimeter dams and the inner beach areas of the NorthMet Tailings Basin. Similar to the Proposed Action, the basin interior would receive bentonite augmentation to reduce infiltration and maintain a partial wet cap (pond). Surface runoff from the partial dry cap would flow to the central area of the basin to maintain the pond and dilute pond water. Emergency overflow structures would be constructed to maintain the desired maximum pond elevations.
- Increased rock buttress material would be placed along the toe of the northern embankment of Cell 2E to improve geotechnical stability.

This alternative also includes demonstration testing of a Permeable Reactive Barrier (PRB) at a representative location north of the Tailings Basin during operations. The PRB test would assess whether such a passive treatment method would be effective in reducing constituents of concern (sulfate, antimony, and arsenic) in the Tailings Basin seepage. If successful, a permanent PRB could be built as a vertical unit and/or a horizontal surface unit (i.e., constructed wetland) through the flow path of the seepage from the Tailings Basin.

Further, if water quality monitoring demonstrated the need, treatment of the pumped seepage could be provided prior to discharge to the Partridge River. Based on current water quality modeling, the discharge of seepage would meet all surface water quality standards and no treatment would be needed.

III.D.2 Impacts of the Tailings Basin Alternative

The Tailings Basin Alternative would have similar effects on all resources as the Proposed Action; however, the water quality management measures at the Tailings Basin would change the potential effects on the following resources relative to the Proposed Action:

Water Resources

- Water Levels in Colby Lake and Whitewater Reservoir - The Maximum Recycle Option should maintain higher water levels in Colby Lake and reduce water level fluctuations in Whitewater Reservoir by limiting the make-up water withdrawals. The No Recycle Option would have negligible effects relative to the Proposed Action.

- Flows in the Lower Partridge River – Average flows would reduce by 3.4 (4%) to 5.4 (5%) cfs but should have negligible effects on river morphology.
- Water Quality in Lower Partridge River – Discharge of Tailings Basin seepage would reduce the assimilative capacity of the Lower Partridge River, but is not predicted to result in any exceedance of surface water standards.
- Groundwater Levels Downgradient of the Tailings Basin - Pumping by vertical wells would reduce the amount of unrecovered NorthMet seepage by approximately 95% during operations and Closure relative to existing conditions.
- Flows in the Embarrass River – Average flow reduced by 1.7 cfs (2%) during operations and 1.9 cfs (2%) during closure, which should have a negligible effect on river morphology.
- Waters that Contain Wild Rice – Reduced water level fluctuations but increased (1 to 9 mg/L) sulfate concentrations in the Lower Partridge River, although sulfate concentrations are already elevated (>100 mg/L) in this area.
- Mercury in Water – Significant reduction in mercury methylation risk in the wetlands north of the Tailings Basin by reducing sulfate loadings over 70% relative to existing conditions.

Wetlands

- The discharge pipeline corridor and East Basin and buttress expansions would directly affect 41.2 acres of scrub/shrub and open water wetlands.
- No indirect wetland impacts north of the Tailings Basin are expected due to seepage capture and discharge to the Lower Partridge River. This represents a reduction of 349.3 acres of indirect impacts relative to the Proposed Action.

Vegetation

- Loss of 45.4 acres of uplands along the water discharge pipeline right-of-way.
- Potential emigration of invasive species through natural migration and seed dispersal due to disturbance within the corridor.

Fish and Macroinvertebrates

- Reduced water level fluctuations and higher average flow rates in the Lower Partridge River relative to the Proposed Action.
- Potential reduction in methylmercury formation in wetlands north of the Tailings Basin and the Embarrass River.

Geotechnical Stability

- Increased stability of the Tailings Basin embankment due to increased buttress.

Cumulative Effects

- The Tailings Basin Alternative would discharge most Tailings Basin seepage to the Partridge River downstream of Colby Lake (not a high risk area for sulfate) and would reduce sulfate loading below existing conditions in the Embarrass River watershed.
- Cumulative decrease in the indirect wetland losses in the region.

III.E NO ACTION ALTERNATIVE

The No Action Alternative was analyzed in the DEIS pursuant to the requirements of NEPA and MEPA.

III.E.1 No Action Alternative Description

Under the No Action Alternative, the proposed Project would not be constructed and open pit mining operations would not occur. At the greenfield Mine Site, PolyMet would reclaim the surface disturbance from the exploratory and development activities and existing surface uses (e.g., logging) would continue. At the brownfield Plant Site, Cliffs-Erie LLC would complete Closure and reclamation activities required under the existing Closure program. Additional Tailings Basin water quality impact measures may also be required.

III.E.2 Impacts of the No Action Alternative Impacts

This alternative would avoid the environmental and social impacts associated with the Proposed Action, Mine Site Alternative, and Tailings Basin Alternative; however, the social and economic benefits from the proposed Project (increased employment and economic revenue) would not occur.

III.F Mitigation Measures for the Project

The mitigation measures identified during scoping were analyzed, revised or eliminated, and additional mitigation measures were identified to create the agency-recommended mitigation measures (Table III-1).

Table III-1 Summary of Mitigation Measures

Resource	Mitigation Measures	Applicability[1]
Water Resources	Increase the stockpile overliner buffer thickness to 24 to 36 inches	PA, MSA
	Provide chemical modification of Category 3 and 4 waste rock and Category 3 lean ore stockpiles	PA, MSA
	Enhance the Category 1 stockpile liner	PA, MSA
	Revise overburden management for sulfate, mercury and other heavy metals, if sampling indicated significant leaching concerns	PA, MSA
	Treat drainage from the Overburden Storage and Laydown Area as process water at the WWTF.	PA, MSA
	Increase the backfill of the East Pit to allow for a geomembrane cover over the entire exposed Virginia Formation	PA, MSA
	Expedite flooding of the West Pit	PA, MSA
	Treat West Pit overflows by various methods, if needed	PA, MSA
	Provide stormwater management at the Plant Site to control runoff from the Processing Plant area	PA, TBA
	Use alternative embankment material at the Tailings Basin	PA, TBA
	Provide an enhanced bentonite cap at the Tailings Basin	PA, TBA
	Provide enhanced Tailings Basin geomembrane cap	PA, TBA
	Retain the seepage barrier to Second Creek after Closure	PA, TBA
	Install a Permeable Reactive Barrier north of the Tailings Basin, if needed	PA, TBA
	Provide Tailings Basin effluent treatment prior to discharge, if needed	TBA
Wetlands	Complete compensatory wetland mitigation on-site, at the Aitkin Site, Hinckley Site, and others as determined through the Section 404 permit process with the USACE	All
	Maximize the elevation of the Category 1 and 2 stockpile	PA, MSA
	Implement a wetland monitoring plan to identify any additional indirect effects on wetlands and provide additional compensatory mitigation, as needed	All
Vegetation	Use a native species seed mix to stabilize disturbed areas during site reclamation	All
	Fence/Flag ETSC plant species along Dunka Road	PA, MSA
	Maximize the elevation of the Category 1 and 2 Waste Rock Stockpile	PA, MSA
	Add organic amendments to the Tailings Basin	PA, TBA
Wildlife	Vehicular prevention and avoidance techniques including speed limits and driver instructions for Dunka Road users	PA, MSA
	Limit access to the Mine Site during reclamation through signage, barriers, berms to facilitate habitat restoration and wildlife use	PA, MSA
Fish and Macroinvertebrates	Develop a mercury monitoring plan for the Mine Site	PA, MSA

Resource	Mitigation Measures	Applicability[1]
Air Quality	No specific mitigation measures are identified at this time; however, additional mitigation could be considered during permitting and operational monitoring, as necessary, including in-state equivalent reductions, cross-sector partnerships, product collections, public owned treatment works, and research.	All
Noise	Adjust blast hole pattern and add delay weights to mitigate vibrations	PA, MSA
	Maintain air overpressure levels through delay weight reductions, appropriate stemming depth, use of shock tubes, and depth of burden	PA, MSA
	Avoid unfavorable atmospheric conditions during blasting	PA, MSA
	Blast on a consistent daily schedule	PA, MSA
Cultural Resources	Develop recordation plan for the Concentrator Building and portions of the facility railroad spur	PA, MSA
	PolyMet intends to propose private lands within the 1854 Ceded Territory for exchange with the USFS	All
Compatibility with Plans and Land Use Regulations	Use a native species seed mix during reclamation	All
Socioeconomics	No mitigation measures identified	All
Visual Resources	Direct operating lights downward to shield light sources	All
Hazardous Materials	No mitigation measures identified.	All
Geotechnical Stability	No specific mitigation measures identified at this time; however, additional mitigation to be considered during permitting and operational monitoring, as necessary, include increasing rock buttresses, dewatering LTV slimes, reducing stockpile height, and modifying benches to reduce slopes.	All

[1] PA - Proposed Action; MSA - Mine Site Alternative; TBA - Tailings Basin Alternative; All - All Alternatives.

III.G AREAS OF MAJOR DIFFERENCES OF OPINION CONCERNING SIGNIFICANT IMPACTS

Minnesota Rules, part 4410.2300, subpart 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 (40 C.F.R. Section 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."

While the lead agencies assess resources of tribal concern in this document, and the USACE will continue to do so through the Section 106 consultation process, differences of opinion remain between the lead agencies and the tribal cooperating agencies. The tribal representatives view themselves as uniquely impacted by mining activities in the 1854 Ceded Territory and it has not been possible to reach agreement on a number of conclusions within the DEIS.

Rather than limiting inclusion of conflicting conclusions to those that are "major differences of opinion concerning significant impacts," this DEIS includes almost all of the tribal position statements submitted in response to the July 2009 preliminary DEIS (Appendix D of the DEIS).

This is in recognition that the document is a joint state and federal DEIS and that the tribal cooperating agencies have participated in the DEIS development through a memorandum of understanding.[1]

The differing opinions are included in footnotes throughout the DEIS. To the extent possible the DEIS uses the position statements as received after tribal cooperating agency review of the July 2009 preliminary DEIS. Some of the tribal positions received led to a revision of the text to incorporate the position, in which case the original position is no longer needed and is not footnoted.

The main differences of opinion are summarized below:

- Potential groundwater quantity and quality impacts in the St. Louis River Basin including the impacts of drawdown from mine pit dewatering on groundwater quantity, the assumptions and results of the groundwater quality and quantity modeling in the DEIS, and the ability of the Project to meet long-term closure requirements relative to groundwater quantity and quality.
- Potential surface water quantity and quality impacts in the St. Louis River Basin including the potential to increase mercury concentrations, potential sulfate impacts to wild rice, applicability of the wild rice standard for surface water quality, leaching of metals to surface water, impacts to flow rates in the St. Louis River Basin, and the ability of the Project to meet long-term closure requirements relative to surface water quantity and quality.
- Potential direct and indirect wetland impacts in the St. Louis River Basin including the potential connectivity between groundwater and wetlands at the Mine Site and the impacts from changes to surface and groundwater quality and quantity; the assessment methodology, extent, and duration of direct and indirect wetland impacts from the Project; and the proposed wetland mitigation plan, including legacy clean-up responsibilities and compensatory mitigation ratios.
- Potential impacts to vegetative cover types, wildlife and aquatic habitat, and protected species in the 1854 Ceded Territory including species of tribal interest (e.g., wild rice and moose), the proposed use of invasive species and monocultures during reclamation, the cumulative effects of disturbance to protected species and wildlife corridors, and the potential for mercury accumulation in fish due to water quality changes from the Project.
- Potential impacts related to extent of noise impacts; the deposition, emission, and accumulation of air pollutants; and the impact of new mining features on the visual landscape in the 1854 Ceded Territory
- Potential environmental, social, and economic impacts to natural resources of tribal concern including wild rice, fish, and other wildlife within the 1854 Ceded Territory
- Potential environmental, social, and economic impacts of a land exchange on tribal land use within the 1854 Treaty Ceded Territory.

[1] *Revised Memorandum of Understanding* dated May 19, 2008 (Appendix C of the DEIS).

IV. NEXT STEPS

IV.A PUBLIC COMMENT PROCEDURES AND PUBLIC MEETING INFORMATION

The DEIS will be published and circulated for a public comment in accordance with MEPA requirements set forth in *Minnesota Rules*, chapter 4410, and with NEPA requirements. Public comments on the DEIS will be accepted during this period via written letter, e-mail, or fax to the agency contacts listed below and via written or oral comment at the public meetings.

The DEIS is available online at
http://www.dnr.state.mn.us/input/environmentalreview/polymet/index.html.
For further information, contact the MnDNR or USACE points of contact identified below.

Two public information meetings will take place during the DEIS comment period: one in the Hoyt Lakes area and one in the Minneapolis - St. Paul metropolitan area.

IV.B FINAL EIS/ROD PROCEDURES

Comments on the DEIS will be taken into account in assessing proposed Project impacts and potential mitigation. Following the end of the DEIS comment period, responses to substantive comments will be prepared and a Final EIS will be issued. The MnDNR will review the Final EIS for adequacy with MEPA following issuance of the Final EIS and a ten-day comment period. The state notice of adequacy will be published in the EQB Monitor.

The USACE will prepare the federal Record of Decision (ROD) and issue a Public Notice regarding its availability no sooner than 30 days after the Final EIS is published. 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.

IV.C AGENCY CONTACT INFORMATION

The MnDNR and USACE are co-lead agencies for preparation of the joint state-federal EIS for the proposed NorthMet Project. Comments, questions, and concerns regarding the DEIS should be addressed to the following individuals:

MnDNR Contact:
Stuart Arkley, EIS Project Manager
Environmental Review Unit
Division of Ecological Resources
Minnesota Department of Natural Resources
500 Lafayette Road
St. Paul, Minnesota 55155-4025
651.259.5089
651.297.1500 (FAX)
Environmentalrev.Dnr@state.mn.us
(reference NorthMet in the subject line)

USACE Contact:
Jon K. Ahlness
Regulatory Branch, St. Paul District
U.S. Army Corps of Engineers
190 Fifth Street East, Suite 401
St. Paul, Minnesota 55101-1638
651.290.5381
651.290.5330 (FAX)
jon.k.ahlness@usace.army.mil

1.0 INTRODUCTION

1.1 BACKGROUND AND LOCATION OF THE NORTHMET PROJECT

The Minnesota Department of Natural Resources (MnDNR) and the U.S. Army Corps of Engineers (USACE), in cooperation with the U.S. Forest Service (USFS), the Bois Forte Band of Chippewa (Bois Forte Band), Grand Portage Band of Chippewa (Grand Portage Band), and the Fond du Lac Band of Lake Superior Chippewa (Fond du Lac Band) have prepared a joint state and federal Draft Environmental Impact Statement (DEIS) for the NorthMet Mine and Ore Processing Facilities Project (NorthMet Project or Project) proposed by PolyMet Mining, Inc. (PolyMet). The purpose of the Project would be to open pit mine low-grade disseminated sulfide mineral ore and process the extracted ore into bulk concentrate; copper concentrate; nickel concentrate; copper metal; and nickel, cobalt, and precious metal precipitates. The DEIS evaluates the Project in accordance with the National Environmental Policy Act (42 USC Sections 4321-4347) and the Minnesota Environmental Policy Act (*Minnesota Statutes*, chapter 116D).

The Project consists of the following major components:

- Mine Site – includes the mine pits, waste rock stockpiles, Lean Ore Surge Pile, Overburden Storage and Laydown Area, Waste Water Treatment Facility, and Central Pumping Station;
- Plant Site – includes the Processing Plant, Tailings Basin, Area 1 and 2 Shops, Main Gate, and the railroad connection; and
- Transportation Corridor - Dunka Road segment, railroad segment, the pipelines and transmission lines between the Mine Site and the Plant Site, and the pipeline between the Plant Site and Colby Lake.

PolyMet proposes to mine (over an estimated 20-year mine life) an average of approximately 91,200 tons per day (tpd) of rock, and up to 32,000 tpd of ore from a new surface mine consisting of three pits (i.e., East, Central, and West Pits). Over the life of the Project, PolyMet would process approximately 228 million tons of base and precious metal ore at the former LTV Steel Mining Company (LTVSMC) taconite processing facility. The processing plant would be refurbished to include a beneficiation plant, which would produce copper and nickel concentrates, and a hydrometallurgical plant, which would produce copper metal and precipitates of nickel, cobalt, palladium, platinum, and gold. The Project would also generate approximately 394 million tons of waste rock and lean ore over the life of the mine, which would be segregated into stockpiles near the mine pits.

The Project would be located on the south flank of the Mesabi Iron Range in St. Louis County, Minnesota, approximately 50 miles north of the city of Duluth, and 25 miles east of the city of Virginia (Figure 1.1-1). In this DEIS, we refer to the Project area, which is defined as including lands within five miles of the Project (Mine Site; Plant Site; Dunka Road segment; railroad segment; and pipeline and transmission line segments) (Figure 1.1-2). The Project area is within the lands in the 1854 Treaty Ceded Territory (Figure 1.1-1). The Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park are approximately 20 miles north and 50 miles northwest, respectively, of the Project area. The Mine Site would be located at a previously unmined area (a greenfield site) in the Superior National Forest two miles south of the active Northshore Mining Company's Peter Mitchell taconite mine (Peter Mitchell Mine) and approximately six miles south of the city of Babbitt (Figure 1.1-2). The Plant Site would be approximately eight miles west of the NorthMet Mine Site and six miles north of the city of Hoyt Lakes at the currently inactive LTVSMC taconite processing facility (a brownfield site). The Mine and Plant Sites are connected by a private railway and the Dunka Road, a private all-weather gravel road.

The Mine Site is located on National Forest lands; however, the mineral rights are retained by private entities and currently under lease to PolyMet. The National Forest lands that would be impacted in PolyMet's mining proposal were acquired in two separate purchases in 1935 by the USFS. The mineral rights to these lands are either reserved or outstanding rights as described below:

- The vast majority of the National Forest lands that are included in PolyMet's mining proposal were purchased in 1935 by the USFS, for National Forest purposes under the authority of the Weeks Act (Act of March 1, 1911, 36 Stat. 961), from the Duluth & Iron Range Rail Road Company. In the deed to the United States, which conveyed 61,973.34 acres of land, D&IR reserved mineral rights subject to the 1911 version of the Rules and Regulations of the Secretary of Agriculture. That deed ("Duluth Deed") is recorded at Volume 640, Page 39 of the St. Louis County land records. These reserved mineral rights are the subject of the lease from USX Corporation. It is the position of the United States that the mineral rights reserved in the 1935 Duluth Deed do not include the right to open pit mine the National Forest lands; and

- Approximately 120 acres of National Forest land included in PolyMet's mining proposal were purchased in 1935 by the USFS, for National Forest purposes under the authority of the Weeks Act from Louise F. Clarke. At the time of the acquisition, the mineral rights to this land were outstanding in a third party, Longyear Mesaba Land and Iron Company ("Longyear"). The deed to the United States from Clarke is recorded at Volume 639, Page 353 of the St. Louis County land records ("Clarke Deed") and conveyed 4,393.77 acres of land to the United States. The severance deed ("Longyear Deed") in which the minerals were reserved by Longyear when it conveyed lands to Clarke was recorded at Volume 590, page 307. It is the position of the United States that the mineral rights reserved in the Longyear Deed do not include the right to open pit mine the National Forest lands.

Given these positions as well as the law applicable to National Forest land acquisition and management, the USFS appears to lack the authority to allow, by decision, open pit mining as proposed by PolyMet. PolyMet disagrees with the USFS interpretation of the deed language and argues that the mineral rights it seeks to utilize provide for access to the minerals by any mining method including open pit or surface mining.

Given the land ownership pattern in the area surrounding the National Forest lands for the proposed open pit mine, the USFS and PolyMet have been having detailed discussions exploring the feasibility for a land exchange. The USFS has identified approximately 6,700 acres of National Forest land to exchange to PolyMet for a yet to be determined non-federal land. PolyMet intends to proposed private lands within the 1854 Ceded Territory. A land exchange would resolve the current split estate between federal surface overlying private minerals by consolidating the surface ownership and mineral rights. Once the current discussions have been completed and a feasible land exchange proposal has been identified, the USFS will be initiating an Environmental Impact Statement (EIS) evaluating the proposed land exchange. A land exchange for land adjustment is consistent with the Superior National Forest *Land and Resource Management Plan* (USDA USFS 2004b, pages 2-51 - 2-52).

Assuming a land exchange would occur, no Project lands would be part of the National Forest and therefore would not be subject to USFS management plans and policies. This DEIS identifies and analyzes the potential alternatives and impacts for the Project based on the successful completion of a land exchange and elimination of National Forest lands from the Project.

1.2 PROJECT PURPOSE AND NEED

The purpose and need of the Project is to produce base and precious metals, precipitates, and flotation concentrates from ore mined at the NorthMet deposit by uninterrupted operation of the former LTVSMC processing plant site. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.

1.3 PURPOSE OF THE DEIS

The purpose of this DEIS is to evaluate the potential impacts of the Project and to recommend measures to avoid, reduce, and mitigate environmental impacts. The USACE received an application from PolyMet to discharge fill material in waters of the United States, including wetlands, to develop the 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 an EIS pursuant to NEPA and its implementing regulations (40 CFR parts 1500-1508). The preparation of a state-level EIS is mandatory for this project pursuant to *Minnesota Rules*, part 4410.4400, which requires an impact assessment on new facilities for mining or processing metallic minerals.

1.4 REGULATORY FRAMEWORK

The proposed ore mining and processing operations, as well as the disposal and reclamation of waste materials, are subject to a combination of federal and state regulations aimed to protect human health and the environment. This section discusses the federal, state, and local regulations that apply to the Project.

1.4.1 National Environmental Policy Act (NEPA)

NEPA requires that federal agencies consider the potential environmental consequences of proposed actions in their decision-making process. The law's intent is to protect, restore, or enhance the environment through well-informed federal decisions. The Council on Environmental Quality (CEQ) was established under NEPA for the purpose of implementing and overseeing federal policies as they relate to this process.

In 1978, the CEQ issued Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR parts 1500-1508). Section 102(2)(c) of NEPA mandates that the lead federal agency must prepare a "detailed statement for legislation and other major federal actions significantly affecting the quality of the human environment." Such projects include any actions under the jurisdiction of the federal government or subject to federal permits; actions requiring partial or complete federal funding; actions on federal lands or affecting federal facilities; continuing federal actions with effects on land or facilities; and new or revised federal rules, regulations, plans, or procedures. Any significant action with the potential for significant impacts requires the preparation of an EIS and a Record of Decision (ROD).

The USACE, during its review of PolyMet's permit application, determined that the Project would require the preparation of an EIS in accordance with the requirements of NEPA and the CEQ regulations. To comply with other relevant environmental statutes described below, in addition to NEPA, the decision-making process for the Proposed Action involves a thorough examination of all pertinent environmental issues. The adequacy of the Final EIS (FEIS) is determined in accordance with 40 CFR part 1505.

1.4.2 Minnesota Environmental Policy Act (MEPA)

In addition to the NEPA process, *Minnesota Statutes*, chapter 116D also requires an environmental review of the Project. The MEPA environmental review process is a decision-making tool for state agencies. It informs the subsequent permitting and approval processes and describes mitigation measures that may be available. The MEPA process operates according to rules adopted by the Minnesota Environmental Quality Board (MEQB). However, the actual reviews are usually conducted by a local governmental unit or a state agency. The organization responsible for conducting the review is referred to as the Responsible Governmental Unit (RGU). The primary role of the MEQB is to advise RGUs and state agencies on the proper procedures for environmental review and to monitor the effectiveness of the process in general. The MnDNR is the RGU for the Project as established under Minnesota Rules.

Minnesota Rules, part 4410.4400, subpart 8 dictate that an EIS shall be prepared because the Project exceeds the threshold listed for construction of a new metallic mineral mining and processing facility. Under MEPA, the DEIS must be consistent with *Minnesota Rules*, part 4410.0200 to part 4410.7800 and the scoping determination. The adequacy of the FEIS is governed by *Minnesota Rules*, part 4410.2800.

In accordance with *Minnesota Rules*, part 4410.2100, subpart 2, all projects requiring an EIS must have an Environmental Assessment Worksheet (EAW) filed with the RGU that becomes the basis for the scoping process. For projects requiring an EIS, the EAW can be used solely as a scoping document. For such projects, the RGU prepares and circulates with the EAW a draft scoping decision document that addresses the contents specified by Minnesota Rules to the extent that information is already available. The purpose of the draft scoping decision document is to facilitate the delineation of issues and analyses to be contained in the EIS. The information in a draft scoping decision document is considered preliminary and subject to revision based on the entire record of the scoping process. Refer to Section 2.1 for discussion of the scoping decision document and EAW for the Project.

1.4.3 Applicable Regulations

In accordance with *Minnesota Rules*, part 4410.3900, to reduce duplication to the fullest extent between the Minnesota Statutes and NEPA, a joint state / federal EIS will be prepared. As such, the Project will be required to comply with both NEPA and MEPA regulations. In addition, PolyMet must obtain the required federal, state, and local permits summarized below (Table 1.1-1).

Table 1.1-1 Government Permits and Approvals for the Project

Agency	Permit/Approval	Reason Permit is (or May be) Needed
Federal		
U.S. Army Corps of Engineers	Section 404 Individual Permit	For impacted wetlands within the jurisdiction of the USACE under the Clean Water Act
	Section 106 Consultation (Minnesota Historic Preservation Office)	Project required a federal undertaking (i.e. USACE wetland permitting was required)
U.S. Fish and Wildlife Service	Section 7 Endangered Species Act (ESA) Consultation	Project required a federal undertaking (i.e. USACE wetland permitting was required)
U.S. Forest Service	No permits are needed; however, a land exchange will be required to resolve the split estate between federal surface rights and underlying private mineral rights.	
State		
Minnesota Department of Natural Resources	Permit to Mine	Required for all nonferrous metallic mining operations
	Endangered Species Taking Permit (if required)	If there are state-listed species that may be taken by the Project
	Water Appropriations Permit for plant make-up water	For withdrawal of water from Colby Lake for plant make-up water; For mine dewatering

Agency	Permit/Approval	Reason Permit is (or May be) Needed
	Dam Safety Permit	For the Tailing Basin, hydrometallurgical residue cells, and potentially the water retention dikes at the Mine Site (e.g., water treatment plant pond dikes).
	Permit for Work in Public Waters	For possible modifications and diversions of local streams in constructing the West Pit outfall
	Wetland Replacement Plan approval under Wetland Conservation Act	For impacted wetlands within the scope of the WCA or that constitute "public wetlands"
	Burning Permit (if required)	If vegetative material would need to be burned on-site during times with no snow cover
Minnesota Pollution Control Agency	Section 401 Water Quality Certification/Waiver	Waived by default in May 2006
	National Pollutant Discharge Elimination System (NPDES) Permits (storm water)	For construction activity that would disturb one acre or more of land
	State Disposal System (SDS) Permit	For construction/operation of wastewater collection and treatment systems and a hydrometallurgical residue facility; For the discharge to groundwater
	Solid Waste Permit	For construction debris
	Air Emissions Permit (Part 70 Permit)	For emissions of regulated air pollutants
	Waste Tire Storage Permit	For storage of waste tires generated from Project-related vehicles (if required)
	General Storage Tank Permit	For multiple Project above-ground storage tanks (ASTs)
Minnesota Department of Health	Radioactive Material Registration	For measuring instruments
	Permit for Non-Community Public Water Supply System and a Wellhead Protection Plan (if proposed)	Existing Plant Site potable water treatment plant to be refurbished
	Permit for Public On-site Sewage Disposal System	For solid waste generated during construction and operation that would be disposed on-site
Local		
City of Hoyt Lakes	Zoning Permit	To acknowledge Project is an allowable use within the zoned Mining District
City of Babbitt	Building Permit	New construction would occur on areas of the Project within the incorporated limits of the City of Babbitt
St. Louis County	Zoning Permit	To acknowledge Project is an allowable use within the zoned district

1.5 AGENCY ROLES AND RESPONSIBILITIES (LEAD AGENCIES, COOPERATING AGENCIES, OTHERS)

The MnDNR and USACE are serving as co-lead agencies in preparation of this DEIS, with MnDNR serving as the RGU under MEPA and the USACE serving as the lead federal agency under NEPA. The Mine Site for the Project is currently located on National Forest lands; therefore, the USFS is participating as a cooperating agency as it is the current federal land manager. The Mine Site and Plant Site are also located within the 1854 Treaty Ceded Territory where the Bois Forte Band, Fond du Lac Band, and Grand Portage Band retain hunting, fishing, and gathering rights under the Treaty of 1854. For this reason, the Bois Forte Band and Fond du Lac Band are also participating as cooperating agencies. A memorandum of understanding (last amended in May 2008) defines the roles and responsibilities of these parties. The Grand Portage Band is not currently a cooperating agency or signatory to the memorandum of understanding; however, they have been involved in the DEIS preparation process as if they were a cooperating agency and recently requested formal confirmation of cooperating agency status for the Project.

The Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) are assisting the MnDNR pursuant to *Minnesota Rules*, part 4410.2200 but are not party to the memorandum of understanding. The U.S. Environmental Protection Agency (USEPA) has an oversight role over the NEPA process and has participated in review of draft documents leading up to the DEIS.

1.6 ORGANIZATION OF DEIS

This DEIS follows the CEQ's recommended organization (40 CFR part 1502.10) and MEPA content requirements (*Minnesota Rules*, part 4410.2300):

- Chapter 1.0 provides descriptions of the purpose of and need for the Proposed Action, agency roles in the EIS process, and the required permits for the Project;
- Chapter 2.0 describes the scoping process, including public participation and the consultation and coordination undertaken to prepare the DEIS, and the alternatives and issues identified during the scoping process;
- Chapter 3.0 describes the Proposed Action and alternatives including the No Action Alternative;
- Chapter 4.0 summarizes the affected environment and the direct, indirect, and cumulative impacts associated with the Proposed Action and alternatives; possible mitigation measures to reduce or minimize impacts; and any residual adverse effects following the implementation of mitigation;
- Chapter 5.0 presents the comparison of alternatives, including mitigation measures;
- Chapter 6.0 describes the irreversible and irretrievable commitment of resources;
- Chapter 7.0 contains the references; and
- Chapter 8.0 is the list of preparers.

1.6.1 Tribal Cooperating Agency Positions Included in the DEIS

Minnesota Rules, part 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 CFR 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."

The lead agencies have included tribal representatives in regular conferences calls to communicate the status of the EIS development, shared all PolyMet documents via an FTP site, and invited tribal representatives to comment on PolyMet documents and preliminary DEIS chapters in conjunction with state and federal agency review. The lead agencies received valuable input and perspective during these interactions. While the lead agencies assess resources of tribal concern in this document, and the USACE will continue to do so through the Section 106 consultation process, differences of opinion remain between the lead agencies and the tribal cooperating agencies.

The tribal representatives view themselves as uniquely and disproportionately impacted by mining activities in the 1854 Ceded Territory[1] and it has not been possible to reach agreement on a number of conclusions within the DEIS.

Rather than limiting inclusion of conflicting conclusions to those that are "major differences of opinion concerning significant impacts" this DEIS includes almost all of the tribal position statements submitted in response to the July 31, 2009 Preliminary DEIS (PDEIS). This is in recognition that the document is a joint state and federal DEIS and that the tribal cooperating agencies have participated in the DEIS development through a memorandum of understanding.[2]

The differing opinions are included in footnotes throughout the document. To the extent possible the DEIS uses the position statements as received after tribal cooperating agency review of the July 31, 2009 PDEIS. Some of the tribal positions received led to a revision of the text to incorporate the position, in which case the original position is no longer needed and is not footnoted.

1 *See e.g.* Tribal Position on Chapter 4.10, Section 4.10.3.1 (Proposed Action; Environmental Justice).

2 *Revised Memorandum of Understanding* dated May 19, 2008.

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.[1]

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 DEIS 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

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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.

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 (see Chapter 5.0 for a discussion of mitigation measures).

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. 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 Chapter 5.0.

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 for Class I areas, 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, an independent study by the International Institute for Environment and Development (2002) aimed at how the mining/minerals sector could maximize sustainable development at the global, national, regional, and local level, 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 reclamation. 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.[2] However, the DEIS does describe reclamation procedures and acknowledges that Minnesota regulations require that financial assurance requirements be determined at the permitting phase and be in place before a Permit to Mine can be issued.

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);

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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.

- Air emissions (Section 4.6);
- Noise (Section 4.7);
- Archeology (Section 4.8);
- 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).[3]

The DEIS will also consider additional issues that arise as the understanding of the potential impacts of the Project evolves through the DEIS analyses and public comment.

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] It is the tribal cooperating agencies position that the Tribes were not involved as Cooperating Agencies during Scoping, or when the Final SDD was issued and that additional consultation and evaluation is needed to determine the degree of impact on the ceded territory as a result of this project.

- 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 less than 2.5 microns in diameter ($PM_{2.5}$);
- Greenhouse gas emissions and climate change; and
- Impacts to wild rice.[4]

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,

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[4] It is the tribal cooperating agencies position that the tribes were not involved as Cooperating Agencies during Scoping or when the Final SDD was issued. The tribal cooperating agencies position is that although groundwater hydrology and impacts to groundwater, Cultural Resources, and impacts to wild rice were "incorporated" after scoping, 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.

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 DEIS 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 September 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 comments on 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 public review 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 near 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 FEIS will be issued. Following issuance of the FEIS and a ten-day comment period, the MnDNR will review the EIS for adequacy with MEPA. The USACE will issue the federal ROD no earlier than 30 days after the FEIS is published. The state notice of adequacy will be published 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. Some of the potential 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 is provided 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). 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 acres that are on top of and

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[1] Unless specified otherwise, all tons in this document are short tons, or 2,000 pounds.

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 agreements had been reached (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 currently owned or leased by PolyMet totals 4,552 acres 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, waste rock 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 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 3,900 tpd of overburden and 55,300 tpd of waste 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, Draft-02; RS22, Barr 2008; and RS24, Barr 2007, Draft-02). These activities would include:

- Upgrading the existing Dunka Road;
- Constructing site access and haul 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;
- Constructing the rail spur between the Cliffs Erie track and existing PolyMet track that serves the Coarse Crusher Building;

- Constructing the Rail Transfer Hopper;
- 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, 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 would be used on-site as construction material in areas approved by 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 (Kearney and Wenigmann 2009). The overburden portion of the Category 1 and 2 waste rock stockpile 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 (PolyMet 2008, *Potential Construction Uses for Category 1 Waste Rock*).

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, foundations for the Rail Transfer Hopper and Ore Handling Area, foundations for the Category 1 and 2 stockpile (PolyMet 2008, *Potential Construction Uses for Category 1 Waste Rock*) and other applications as approved by the MnDNR during permitting.

The pre-production mine development would be followed by a gradual ramp-up of ore output over 6 to 12 months to reach the planned rate of mining. 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 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 (referred to as the East Pit after Year 13).

By placing Category 1 and 2 waste rock (the least reactive material) into the East Pit through the end of the mine life with an inflow of water, the rock would be stored in a subaqueous environment to reduce the environmental impact associated with the oxidation and decomposition of sulfide minerals. Moreover, once backfilled, the combined East 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. At its maximum size, each pit is projected to have the approximate maximum area and 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.

Table 3.1-2 Proposed Blasting Parameters

Blast hole diameter (range)	10 – 16 inch
Explosive type/blasting agent	ANFO, emulsion and emulsion blends (ANFO and emulsions)
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 would be staged on the lined Lean Ore Surge Pile for future transport to the Processing Plant, 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 or loaded directly into rail cars at the Direct Loadout Area (part of the Lean Ore Surge Pile).

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 ore until it can fit into the processing schedule or as required by rail haulage delays. 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 Processing 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 stockpile for transport to either the Rail Transfer Hopper or to the Direct Rail Loadout Area of the Lean Ore Surge Pile. Because material in this stockpile is classified as Category 4 waste rock (based on sulfur content; see Section 3.1.2.10), 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 (RS22, 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. 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 system. 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 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 Storm Water Pollution Prevention Plan (SWPPP).

3.1.2.9 Mine Site Water Management

Both Mine Site non-contact stormwater and 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, Draft-02). 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 WWTF located south of the West Pit (RS29T, Barr 2007).[3]

The effluent from the WWTF would be pumped via the CPS to the Tailings Basin for use as plant make-up water (RS22, Barr 2008) or used to supplement flooding of the East Pit while the East 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 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 Plant as described in Section 3.1.5.2 (RS29T, Barr 2007).[4]

The WWTF would consist of two parallel units that would occupy five acres during peak capacity. The WWTF would use nanofiltration treatment for process water flows with lower concentrations of dissolved metals and sulfate, and chemical precipitation treatment for process water flows with high concentrations of dissolved metals and sulfate. The WWTF would include the following: a flow-equalization pond system to ensure a constant flow to the treatment system; an ultrafiltration unit with two parallel banks of filters for nanofiltration pre-treatment; two banks of spiral-wound membranes used for nanofiltration; chemical addition and mixing equipment for chemical precipitation; tanks for coagulation and flocculation; two clarifiers installed in parallel to assist in chemical precipitation; and a re-carbonation process to reduce the pH of effluent (RS29T, Barr 2007).

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 (RS22, Barr 2007, Draft-02). 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 (RS24, Barr 2007, Draft-02). 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, Draft-02; RS25, Barr 2007, Draft-02; and RS25, Barr 2008).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] It is the position of the tribal cooperating agencies 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.

[4] It is the position of the tribal cooperating agencies that under the proposed project, the CPS would need to operate for hundreds or thousands of years in conjunction with the WWTF.

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 pit 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 Draft-02; RS25, Barr 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 (RS49, Golder 2007, Draft-02). 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 (see Section 3.1.2.10 for the definition of waste rock types) 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 defined according to the geochemical and associated acid-producing and metals-leaching properties of the waste rock. These waste rock categories are summarized below (Table 3.1-6).

Table 3.1-6 Summary of Waste Rock Properties

Waste Rock Categorization	Sulfur Content (%S)[1,5]	Copper to Sulfur Ratio (Cu/S)[2,5]	Approximate % of Waste Rock Volume[3]
Category 1	%S ≤ 0.12		74%
Category 2	0.12 < %S ≤ 0.31	≤ 0.3	9%
Category 3	0.12 < %S ≤ 0.31	>0.3	14%
	0.31 < %S ≤ 0.6		
Category 4[(4)]	0.6 < %S	Not relevant	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 when Sulfur Content is between 0.12 and 0.31.
3 ALT 10, Barr 2008.
4 Includes all Virginia formation rock.
5 RS23T, 2007.

- 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) (PolyMet 2008, *Potential Construction Uses for Category 1 Waste Rock*);

- 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 of waste rock would be placed on the Category 4 Stockpile. If considered to be Category 4 lean ore, the material would be hauled to the Rail Transfer Hopper or stored on the Lean Ore Surge Pile; and

- 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 (between 0.01 and 0.12 percent sulfur) and metal concentrations and has been shown to leach low concentrations of metals (SRK 2008, *Results of Analysis from Overburden Drilling Program*). PolyMet expects runoff from this unsaturated overburden, whether placed in the Overburden Storage and Laydown Area, or used for construction, to meet surface water standards without treatment. 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, which 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) and delivered to the Processing Plant.

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 percent 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; saturated overburden, unsaturated overburden, and organic soils (peat) (Kearney and Wenigmann 2009). Recent testing indicates that some of the saturated overburden contains iron sulfides and produced lower pH water in laboratory tests. Stockpiling of this material would expose it to oxidation and could result in acidic conditions, which promote the release of certain metals, especially cobalt, copper, nickel, and zinc, as well as sulfate (Kearney and Wenigmann 2009). Laboratory analysis of the saturated overburden found that it had a median sulfur concentration of 0.06 percent, consistent with Category 1 Waste Rock, but a maximum concentration as high as 0.63 percent, which would be equivalent to Category 4 Waste Rock. Overburden pebble chemical analysis reported a median sulfur concentration of 0.11% for Duluth Complex pebbles and 0.14 percent for Virginia Formation pebbles, with an overall maximum concentration of 2.8 percent (SRK, 2009, *Overburden Pebble Chemical Analysis Draft*). Based on the samples tested, the peat and unsaturated overburden are expected to generate leachates with lower sulfate and dissolved metal concentrations than from the saturated overburden.

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 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 (RS22, Barr 2008).

The Project would place all of the saturated overburden in the Category 1 and 2 Waste Rock Stockpile, extend the Category 1 and 2 liner system under the overburden material, and compact the overburden material as it is placed to limit oxidation and infiltration (Kearney and Wenigmann 2009), although the effectiveness of compaction to limit oxidation is uncertain. 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 temporary storage and re-use as construction or reclamation material.

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).

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 99.4 acres for overburden disposal. The Category 1 and 2 stockpile is 464.0 acres without overburden – see Table 4.4-B in RS-74A, Barr 2008.

Waste Rock Liner and Cover Systems

The waste rock stockpiles would include liner systems to capture water passing through the stockpile. In areas where the underlying soils are not geotechnically stable, overburden would be removed and a stable foundation would be built from Category 1 waste rock. Stockpiles would be constructed using foundation underdrains, if necessary, to provide gravity drainage where elevated groundwater is encountered to prevent or minimize the potential for excess pore pressures as the stockpile is loaded (RS49, Golder 2007, Draft-02). In addition, all liner systems would consist of a barrier layer (that limits the vertical infiltration of water through the liner system) and an overliner drainage layer (that promotes the conveyance of water that reaches the barrier layer to a collection removal point via gravity) (RS23T, Barr 2007). Water collected on stockpile liners would be routed to the Mine Site WWTF and treated. 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 (Kearney and Wenigmann 2009). The proposed liner and cover systems are shown in Table 3.1-9.

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 acres) (OB – 99.4 acres)	12-inch compacted ($5x10^{-7}$ cm/s) subgrade covered by 12-inch overliner drainage layer.	2-foot vegetated 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 vegetated 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 vegetated 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 Surge	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 Processing Plant. The cars would have hinged sides that drop down when the cars are tipped at the Coarse Crusher for unloading. 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 are 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. The intent is to keep fines from reaching the edge of the car where they would be subject to spillage through the hinge gaps.[5]

2) Large pieces of ore over the tops - standard operating procedure would be to use a rubber-tired dozer or a front end loader 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 Coarse 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.[6]

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 138 Kv transmission lines serve the Project substation;

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[5] It is the position of the tribal cooperating agencies that the amount of ore that could escape from the rail cars would not 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.

[6] It is the position of the tribal cooperating agencies that they 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 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). This water would be used for showers and sinks and would be treated (chlorinated) to be drinkable. However, bottled water would 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 impacted by LTVSMC operations. 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). 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[7] (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 located in the Fine Crusher Building.

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 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 located in the Concentrator Building. 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 is 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 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).

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7 Average is calculated using the hours the Primary Crusher is actually running, as it would not run continuously.

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 sulfur 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 flocculent 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[8]

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 high pH would cause the copper to remain highly floatable, forming the majority of the froth which would be considered a copper concentrate. The high pH would also depress the floatability of nickel, which would cause the nickel to remain in the slurry. Because copper and other associated minerals would be removed here, this 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. 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.

8 Note that the Project would only operate in Concentrate Mode temporarily, such as during construction/ commissioning and maintenance of the Hydrometallurgical Plant.

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, loading would be performed indoors on concrete floors.

Processing Parameters

Table 3.1-10 shows PolyMet's estimates for daily production rates and size reduction through the processing steps in the beneficiation process. The rates and sizes provided are the values PolyMet would use to design plant piping and equipment.

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 Design Processing Parameters

Input				Output		
Step	**Material**	**Rate (stpd)**	**Size (inches)**	**Material**	**Rate (stpd)**	**Size (inches)**
Ore Crushing	ore	32,000	48	Ore	32,000	0.315
Ore Grinding	ore	32,000	0.315	Ore	32,000	4.7×10^{-3}
Flotation	ore	32,000	4.7×10^{-3}	Concentrate	1,038	4.7×10^{-3}
				Tailings	30,962	4.7×10^{-3}
Concentrate Grinding	concentrate	1,038	4.7×10^{-3}	Concentrate	1,038	5.9×10^{-4}
Concentrate Separation and Dewatering	concentrate	0 to 1,038	4.7×10^{-3}	Dried nickel and copper concentrates	0 to 1,038	4.7×10^{-3}

Source: PolyMet 2006, Table 3.3.1.1-A.

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
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, Email to April Anderson, ERM. "Re: NorthMet – Please Verify Table data."

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 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[9] 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 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 cooled slurry would be pumped to the leach residue thickener where the solids would be settled with the aid of a flocculant. 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.

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[9] Raffinate is a solution that has been upgraded or refined by a process step.

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 would be pumped directly to the gold and platinum group metals thickener where CuS enriched with gold and platinum group metals would settle with the aid of a flocculant and produce 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 flocculant 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 (Ni/Co) 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 and cobalt 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.

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 Hydroxide	17,500 tpy	Rail (11 tank cars/mo)	60% w/w magnesium hydroxide slurry	Adjacent to General Shop Building	Magnesium Hydroxide 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, Email to April Anderson, ERM. "Re: NorthMet - Please Verify Table data (Table 3.1-11).")

[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, Email to April Anderson, ERM. "Re: NorthMet – Please Verify Table data (Table 3.1-11).")

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 Plant	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 hydrometallurgical plant process water (see Sections 3.1.7.1 and 3.1.7.2)
Potable Water	Existing Processing 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 proposed in the June 2005 Scoping EAW. To resolve geotechnical questions with the original proposed design, PolyMet proposed a Tailings Basin – Mitigation Design (RS13B, Barr 2008; Barr 2008, *Preliminary Geotechnical Evaluation*; and Barr 2009, *Flotation Tailings Management Plan)*. This design is described below. As of June 2009, the Proposed Action – Mitigation Design became the Proposed Action and will be referenced as such throughout the DEIS.

Under the Proposed Action, flotation tailings would be placed on 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 first constructing perimeter embankments (starter dams) and placing tailings from the iron-ore process directly on native material. Perimeter embankments were initially constructed from rock and subsequent perimeter dams were constructed of coarse tailings 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, *Flotation Tailings Management Plan*).

The future Tailings Basin perimeter dams (Figure 3.1-28) would be raised in an upstream construction method using compacted 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 specifications. The Proposed Action also includes a mid-slope setback and construction of buttresses which would be from LTVSMC Area 5 material (Barr 2009, *Flotation Tailings Management Plan*).

The NorthMet tailings would be deposited in slurry form through a system of pumps and moveable pipelines. 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 by gravity flow over discharge beaches when necessary and subaqueously 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 Beneficiation 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 (up to the maximum of 1,732 feet Mean Sea Level [msl]) 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 (Barr 2008, *Technical Memorandum: 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 high quality gypsum filter cake (gypsum), which would be produced annually in the solution neutralization circuit.

These hydrometallurgical residues which would include the non recoverable metal portion of 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 permitting (RS28T, Barr 2008).

The first hydrometallurgical residue cell would be developed over two construction seasons. Most of the earthwork and placing the liner in the lower elevations of the cell would occur in the first year of construction. The remaining earthwork and completion of the liner installation for the upper elevations of the cell 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.

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, NorthMet 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 cell cover system is needed. A composite cover consisting of a geosynthetic clay barrier layer and 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, Barr 2008, *Proposed Hydrometallurgical Residue Cell Closure Approach*). Turf and final cover would be inspected and maintained by mowing once per year or as needed, fertilizing when visual inspection indicates poor vegetation growth, and repair within four weeks after visual inspection indicates erosion or stressed vegetation (RS52, Barr 2007).

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 is estimated at 370 gpm, but varying from 0 to 660 gpm monthly as operating and climatological variations occur (RS29T, 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 from the Hydrometallurgical Residue Facility to the Hydrometallurgical Plant.

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, *Flotation Tailings Management Plan*). This seepage recovery system would be placed approximately 200 to 250 feet downstream of the seepage face. While this seepage recovery system would collect some 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.

The primary source of process water for the Beneficiation Plant and the Hydrometallurgical Plant is the Tailings Basin which includes treated water piped from the Mine Site, via the Tailings Basin. Process water needs above and beyond that would be pumped from Colby Lake.

These water management methods would result in no direct 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 Consumables and 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.

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.

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). 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 part 6132.3200. 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 proposed three year schedule or as approved by the MnDNR commissioner. 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. 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 (RS52, 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 part 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 part 6132.3200 (RS52, 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 part 6132.3200).

Special Material Disposal

Special materials on-site at the time of Closure would be disposed of as follows:

- Asbestos-Containing Materials (ACMs) – a 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; and
- *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 above ground storage tanks (ASTs) and remove without disassembly.

Other Closure Details

There are several places where concentrate having up to 20% sulfur 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 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 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 flood and have a net outflow of surface water. Outlet structures would establish the steady-state water levels in the East and West pits after Closure. Overflows from the East Pit would flow to the West Pit through a new ditch (Figure 3.1-40). The East 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 flood naturally with groundwater, precipitation, and surface runoff from the tributary watershed. This is projected to result in flooding the West Pit around Year 65 and subsequent overflow to the Partridge River (RS74A, Barr 2008).

Mine Pit – Mine Wall Sloping and Revegetation

In accordance with *Minnesota Rules*, part 6132.2300, the minimum requirements are that 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 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 rock material.[10] If left exposed to the air, oxidation of this surface would occur, resulting in elevated concentrations of dissolved salts (sulfates) and metals entering the East 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 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 (Barr 2008, *External Memorandum: 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 soil. 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.

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.

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[10] 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.

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 during the first normal planting period 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 6132.0100, subpart 32) adequate for vegetation growth. To provide erosion control, catch benches at least 30 feet in width would remain on all waste rock stockpiles.

Stockpiles would be capped either with a geosynthetic membrane or with a soil cover and all would be vegetated (see Table 3.1-9). Based on the limited preliminary geotechnical investigation (RS49, Golder 2007, Draft-02), the soils at the Mine Site are predicted to perform favorably as soil cover materials. The vegetated soil cover would be designed to promote runoff with minimal erosion and retain water until it is either transpired through vegetation or evaporated from the soil surface. The soil cover would 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.

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 for final polishing 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 (RS52, Barr 2007).

The pump and pipeline design proposed for the Lean Ore Surge Pile and Overburden Storage and Laydown Area would be removed during Closure with the removal and reclamation of these areas. The Lean Ore Surge Pile, Overburden Storage and Laydown 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 during the first normal planting period. 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 (RS22, 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 Pit would remain in place with the purpose of minimizing mixing of the Partridge River flows with the East 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, any subsurface seepage control components 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.

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 3.1-40 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 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 Pit with the purpose of minimizing the mixing of the Partridge River flows with the East 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 stormwater 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.[11]

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 permanent 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.

Reclamation – Tailings Basin

Upon Closure of the Tailings Basin the following strategies would be applied (Barr, 2009, *Flotation Tailings Management Plan*):

- 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 of the Basin by mulching and establishment of permanent vegetation; and
- Periodic evaluation of dam stability by a qualified geotechnical engineer.

In addition, within 3 years (*Minnesota Rules*, part 6132.3200 subpart 2) emergency overflow channels and/or outfall structures would be constructed to carry excess stormwater 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 flow 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 stormwater. 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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[11] 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.

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 and wetland would remain in the Tailings Basin in Closure. In general, the pond's maximum extent would be maintained to be no closer than 625 feet from the interior edge of the Cells 1E and 2E embankments. Approximately 1,000 feet of the outer area of the pond would be a constructed (Barr 2009, *Flotation Tailings Management Plan*). Water would continue to be pumped from Colby Lake as needed to maintain the pond and wetland. The pond and wetland would also receive surface water runoff from the crest and beaches of the basin. The pond and wetland 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 Second Creek (also known as Knox Creek). This water would be recycled back into the pond water (see 1st bullet above); and

- 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 MnDNR 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 and contains material that overflowed from sumps in the concentrator during LTVSMC operations (Figure 3.1-44).

The Emergency Basin currently overflows through a culvert that is used to prevent any petroleum products floating on the surface of the 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 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. [12]

Cover and Surface Water Runoff Control

The closure surface of the hydrometallurgical plant area 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 barrier layer system would be placed. 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 (RS28T Memo 01, Barr 2008). Turf and final cover would be inspected and maintained by mowing once per year or as needed, fertilizing when visual inspection indicates poor vegetation growth, and repair within four weeks after visual inspection indicates erosion or stressed vegetation (RS52, Barr 2007).

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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[12] 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.

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.[13]

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, possibly, 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. The effluent from the WWTF would be monitored on a daily and monthly basis (RS52, Barr 2007) 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 until such time as the various facility features are deemed environmentally acceptable, in a self-sustaining and stable condition.[14]

Other continued maintenance activities that would continue throughout Closure and Post-Closure would include repair of stockpile and tailings dike slope erosion, wetland and outflow structure up-keep to ensure they are functioning properly, woody species and tree removal on stockpiles and hydrometallurgical cells with membranes, tailings pond maintenance, and seepage collection from the Tailings Basin.[15]

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.[16]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[13] It is the position of the tribal cooperating agencies 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).

[14] It is the position of the tribal cooperating agencies that the potential long term impacts of the project and the potential need for post closure activities would continue for hundreds or thousands of years.

[15] It is the position of the tribal cooperating agencies that these activities would also have to be conducted in perpetuity.

[16] 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 potential impacts to the 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 that elements of the Proposed Action would cause potentially significant adverse impacts.[17]

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 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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[17] Tribal cooperators note that the scoping 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.

3.2.1 No Action Alternative

Under the No Action Alternative, the Project would not be constructed and PolyMet's proposed 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 be reclaimed according to the Cliffs Erie 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.[18] Local employment and economic revenue would not increase as a result of this alternative. 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 (including Post-Closure) 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 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 impacted areas under the Voluntary Investigation and Cleanup (VIC) Program, former Plant Site building removal, and Tailings Basin embankment seep management.

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 at the Mine Site. This alternative would subaqueously dispose of the most-reactive waste rock (all Category 2, 3, and 4) in the East Pit instead of the least reactive waste rock (Category 1). Category 3 lean ore could be processed (removing sulfur) to the extent project economics would allow rather than backfilling all of this material to the East Pit.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[18] 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.

Category 2, 3, and 4 waste rock would be placed in temporary surface stockpiles (Figure 3.2-1) constructed with the same liner systems as in the proposed Project (Table 3.2-1). These stockpiles would be temporarily used to store the waste rock until mining of the East Pit is completed and it becomes available for subaqueous waste rock disposal. Limestone or lime would also be added to the temporary stockpiles to neutralize acid formation. The Category 4 lean ore would be processed as it is mined.

Table 3.2-1 Summary of Proposed Mine Site Alternative Stockpile Liners and Caps

Stockpiles	Stockpile Duration	Stockpile Area (Post-Closure)	Liner System	Cap System
Category 1 Waste Rock and Overburden	Permanent	563.8 acres	12-inch compacted subgrade covered by 12-inch overliner drainage layer.	2-foot evapotranspiratation cover
Category 2/3 Waste Rock (to be converted to Category 1)	Temporary (Years 1-19) Permanent Category 1	72.0 acres	12-inch compacted subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer	2-foot evapotranspiration cover (implemented after conversion to Category 1 stockpile
Category 3 Lean Ore (to be converted to Category 1)	Temporary (Years 1-15) Permanent Category 1	123.7 acres	12-inch compacted subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer	2-foot evapotranspiration cover (implemented after conversion to Category 1 stockpile)
Category 4 Waste Rock	Temporary Years 1-20	0 acres (max of 63.3 acres during operations)	12-inch compacted subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer.	Stockpile is completely removed and reclaimed at Closure so no Cap System is proposed
Lean Ore Surge Pile	Temporary Years 1-20	0 acres (max of 54.5 acres during operations)	12-inch compacted subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 12-inch overliner drainage layer.	Stockpile is completely removed and reclaimed at Closure so no Cap System is proposed

Source: Table 4-34 and pages 49-52, RS74A, Barr 2008.

3.2.3 Tailings Basin Alternative

This alternative consists of a modified design at the Tailings Basin (Figure 3.2-2). No changes would be made to the Mine Site or transportation/utility facilities. The goal of this alternative is to increase the geotechnical stability of the Tailings Basin and to minimize impacts to the wetlands north of the Tailings Basin and in the Embarrass River that may arise from seepage water. The alternative reduces the Project's potential impacts to surface and ground water quality by capturing approximately 95 percent of the seepage generated from the PolyMet operation including from the proposed NorthMet tailings by a series of vertical wells installed on the lower-most bench of the tailings facility (Anderson 2009, *ERM Briefing Memo – Northmet Tailings Basin Alternative*). 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 treatment facility would be installed.[19] Treatment of the unrecovered seepage using a Permeable Reactive Barrier (PRB) would be tested during operations along the northern toe of the Tailings Basin to determine the viability of installing a full-scale system during Closure. If proven to be successful, this treatment system could be used to provide *in-situ* water quality treatment in lieu of long term pumping by the vertical wells. Geotechnical stability would be enhanced by increasing the size of the rock buttress along the northern toe of the Tailings Basin.

The basic components of the Tailings Basin 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, two different options for recycling the seepage are considered. The "Maximum Recycle Option" would return nearly the maximum amount of reusable seepage as make up water at the Plant Site in lieu of water withdrawals from Colby Lake. The remaining captured seepage would be pumped to the Partridge River downstream of the Colby Lake Outlet Structure. The "No Recycle Option" would not use any recovered seepage for make-up water and would pump all the seepage to the Partridge River downstream of the Colby Lake Outlet Structure (surface seepage would also be captured and returned to the Tailings Basin as under the Proposed Action). This alternative would provide flexibility during operations to determine where to discharge pumped groundwater seepage based on water quality. The maximum amount of water would be recycled to the Tailings Basin, to minimize the hydrologic impacts of the Colby Lake water withdrawals on the Partridge River, 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. During Closure and Post-Closure, all water would be pumped directly to the Partridge River (since make up water would no longer be needed 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 (Barr 2009, *Tailings Basin – Alternative Pump-Out Well Locations*; Barr 2009, *PolyMet Mitigation in Tailings Basin Area - Combination 9F*; and Barr 2009, *PolyMet Mitigation in Tailings Basin Area - Details in Combination Evaluation, TBM-1A Pump from Vertical Wells within LTVSMC Facility*).

(2) ***Partial dry capping*** of the NorthMet Tailings Basin upon Closure. This cap would be constructed of either a bentonite clay amended soil or geomembrane. 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

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[19] 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.

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 (Radue 2009, Personal Email Communication with Stuart Arkley, MnDNR, and Dave Blaha; Barr 2009, *PolyMet Mitigation in Tailings Basin Area – Details in Combination Evaluation, TBM-7A Partial Dry Closure Cover*).

(3) ***Increased rock buttress material*** from LTVSMC Area 5 would be placed along the toe of a portion of the northern embankment of Cell 2E (Barr 2009, *PolyMet Mitigation in Tailings Basin Area – Details in Combination Evaluation, TBM-6 Increase Rock Buttress*).

This alternative also includes demonstration testing of a Permeable Reactive Barrier (PRB) at a representative location north of the NorthMet Tailings Basin during operations. This demonstration test would assess whether such a passive treatment method would be effective in reducing constituents of concern (sulfate, antimony, and arsenic) in Tailings Basin seepage. If 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). The PRB, if built, may require periodic recharging (Barr 2009, *PolyMet Mitigation in Tailings Basin Area – Details in Combination Evaluation, TBM-17 Permeable Reactive Barrier*).[20]

3.2.3.1 Tailings Basin Alternative Development Process

The Tailings Basin Alternative resulted from the comprehensive mitigation planning effort by the co-lead agencies, and included input from all Cooperating Agencies and consulting tribes.[21] The mitigation planning effort addressed four potential issues: 1) Uncertainty regarding groundwater contaminant sorption; 2) Uncertainty regarding potential impacts to wild rice as related to sulfate concentrations; 3) Uncertainty regarding potential methyl mercury formation as related to sulfate concentrations; and 4) Uncertainty regarding geotechnical safety factors. Potential mitigation measures were identified that addressed one or more of the potential issues and were evaluated according to their technical, economic, and regulatory feasibility and whether they meet the Purpose and Need for the Project. Potential mitigation measures found to not meet these criteria were eliminated from consideration as stand alone measures (Table 3.2-2).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[20] 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.

[21] 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.

Several of the remaining potential mitigation measures were coupled into a series of potentially viable Combinations, supplemented by additional measures, and re-evaluated according to technical, economic, and regulatory feasibility and the ability to meet the Purpose and Need for the Project (Table 3.2-3). The Tailings Basin Alternative resulted from the combination of several potentially viable individual mitigation measures, collectively referred to as Combination 9F (Table 3.2-3). Preliminary, semi-quantitative impact assessments indicated this alternative would reduce the adverse environmental impacts and would likely be feasible from a technical, economic, and regulatory perspective, in addition to meeting the Project Purpose and Need. The MnDNR and USACE determined that none of the other combinations offered comparable overall benefits in a practicable manner. Not all of the screened mitigation measures were incorporated into evaluated combinations; however, some aspects of the combinations or individual mitigation measures could have potential additive benefits if it is determined they are needed (see Section 4.1).

Table 3.2-2 Screening of the NorthMet Tailings Basin Individual Mitigation Measures

Mitigation Measure Number	Potential Mitigation Measure	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Regulatorily Feasible	Rationale
Potentially Viable Individual Mitigation Measures						
TBM-1	Groundwater Pumping	Yes	Yes	Yes	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, additional measures would be needed to wholly address treatment of the Tailings Basin seepage.
TBM-2	Physical Barrier at Toe (2E seeps or beyond)	Yes	Yes	Yes	Yes	This mitigation measure would address three of the four issues identified in the Tailings Basin mitigation process (excluding geotechnical stability); however additional measures would be needed to wholly address the Tailings Basin concerns.
TBM-3	Full Liner	Yes	Yes	No	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, the stability of the center of the basin would possibly require extra support. The operational cost of this measure would be high and would result in a surface water discharge from the Tailings Basin.
TBM-4	Thickened or Paste Tailings	Yes	Yes	No	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process without the stability concerns of the full liner (TBM-3). The operational cost of this measure would be high.
TBM-5	Reduce Sulfate (from Mine Site waste rock collection) via Mine WWTF	Yes	Yes	Yes	Yes	This mitigation measure would only address sulfate-related concerns (wild rice and methylmercury) identified in the Tailings Basin mitigation process and the benefits would be limited to the first 11 years of operations. Additional measures would be needed to wholly address the Tailings Basin concerns.
TBM-6	Increase Rock Buttress	Yes	Yes	Yes	Yes	This mitigation measure would only address the geotechnical stability concerns identified in the Tailings Basin mitigation process. Additional measures would be needed to wholly address the Tailings Basin concerns.
TBM-7	Dry Closure Cap (organics, paper mill res, soil, etc.)	Yes	Yes	Yes	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, the effects would be limited to Closure. Additional measures would be needed to wholly address the Tailings Basin concerns throughout mine life.
TBM-8	Chemical Modification to NorthMet Tailings	Yes	Yes	Yes	Yes	This mitigation measure would address three of the four issues identified in the Tailings Basin mitigation process (excluding geotechnical stability); although, the change in pH of the tailings may lead to an increase in the leaching of some constituents.
TBM-9	Direct piping of leachate from the Tailings Basin to Partridge River watershed	Yes	Yes	Yes	Yes	This mitigation measure would fully address one (methylmercury) of the four issues identified in the Tailings Basin mitigation process and partially address an additional issue (contaminant sorption in groundwater only). This measure would decrease the methylmercury formation in the Embarrass River watershed; however, it would transfer those contaminants to the Partridge River.

Mitigation Measure Number	Potential Mitigation Measure	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Regulatorily Feasible	Rationale
TBM-11	Partial Liner (cover of LTV coarse tailings)	Yes	Yes	Yes	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process similar to the Full Liner option (TBM-3). This measure would decrease stability of the embankments, would still allow for some seepage from the Tailings Basin, and would require a surface water discharge.
TBM-15	Timed release of sulfate water to the Embarrass River	Yes	Yes	Yes	Yes	This mitigation measure would only address the methylmercury issue identified in the Tailings Basin mitigation process. This measure would require additional storage and treatment capacity prior to the timed release and current research is inconclusive on the optimal release schedule.
TBM-16	Partial treatment of pond water	Yes	Yes	Yes	Yes	This mitigation measure would address three of the four issues identified during the Tailings Basin mitigation process (excluding geotechnical stability); although the effects of this measure on contaminant sorption would be limited to the operations phase. Additional measures would be needed to wholly address the Tailings Basin concerns.
TBM-17	Permeable Reactive Barrier (PRB) downgradient of the toe of the Tailings Basin	Yes	Yes	Yes	Yes	This mitigation measure would address three of the four issues identified during the Tailings Basin mitigation process (excluding geotechnical stability). This measure would potentially treat the Tailings Basin discharge without affecting local hydrology. Additional measures would be needed to wholly address the Tailings Basin concerns
TBM-18	Use of other embankment source material	Yes	Yes	Yes	Yes	This mitigation measure would address all four of the issues identified during the Tailings Basin mitigation process; however, there would not be sufficient overburden available to complete the embankment. Waste rock could supplement the use of overburden; however all Project-related waste rock would be reactive.
TBM-19	Angled drain system. TBM-19a drains run into and pull from the tailings; TBM-19b drains run into and draw from the till below the Tailings Basin.	Yes	Yes	Yes	Yes	This mitigation measure would address all four of the issues identified in the Tailings Basin mitigation process; however, this measure would only have a 25-35% capture efficiency.
TBM-20	Collection ditch around toe of the Tailings Basin	Yes	Yes	Yes	Yes	This mitigation measure would address three of the four issues identified in the Tailings Basin mitigation process (excluding geotechnical stability) and would have the same recovery efficiency of TBM-1 and TBM-2 with the added potential for a surface water discharge. Additional measures are needed to wholly address the Tailings Basin concerns.
TBM-24	Lining of Cell 2W for disposing of the NorthMet tailings (5-20 years capacity)	Yes	No	No	Yes	This mitigation measure would address all four of the issues identified in the Tailings Basin mitigation process; however, this measure would introduce some geotechnical stability concerns due to height, limit access to Cell 2E materials, and require relocation of the hydromet facility.

Mitigation Measure Number	Potential Mitigation Measure	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Regulatorily Feasible	Rationale
Individual Mitigation Measures Considered but Eliminated						
TBM-12	Modified embankment with LTV Cell 2W tailings (from the Cell 2W embankment)	Yes	Yes	Yes	Yes	This mitigation measure would only address the geotechnical stability issues identified in the Tailings Basin mitigation process. It was determined that the Cell 2W embankment does not provide sufficient material; therefore, this mitigation measure was eliminated from further consideration.
TBM-13	Induced consolidation of LTV toe slimes	Yes	Yes	Yes	Yes	This mitigation measure would only address the geotechnical stability issues identified in the Tailings Basin mitigation process. It was determined that there was no known viable method for consolidating the toe slimes (sand drains may warrant further evaluation); therefore, this mitigation measure was eliminated from further consideration.
TBM-14	Collection/ incorporation of LTV Pit 5 water into NorthMet process	Yes	Yes	Yes	Yes	This mitigation measure would only address one (wild rice) of the four issues identified in the Tailings Basin mitigation process. Therefore this mitigation measure was eliminated from further consideration.
TBM-21	Alternative location of a new basin (off the LTV tailings)	Yes	Yes	No	Yes	This mitigation measure would address all four of the issues identified in the Tailings Basin mitigation process. It was determined that this measure would result in new, large-scale disturbance and the required dam heights at the new location would be infeasible; therefore, this mitigation measure was eliminated from further consideration
TBM-22	Manage sulfate loading from LTV waste rock sites (not PolyMet)	N/A	Yes	Yes	Yes	This mitigation measure would only address the one (methylmercury) of the four issues identified in the Tailings Basin mitigation process. It was determined that these waste rock sites are not under the control of PolyMet; therefore this mitigation measure was eliminated from further consideration.
TBM-23	Off-site in-pit subaqueous disposal of tailings	Yes	Yes	Yes	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, this measure was also evaluated during the scoping phase of the EIS and eliminated because off-site pits were either unavailable or did not provide sufficient capacity. Therefore, this mitigation measure was eliminated from further consideration
TBM-25	Redesign the Project to underground mine and use mine to deposit tailings storage	Yes	Yes	No	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, this measure was also evaluated during the scoping phase of the EIS and eliminated due to economic, safety, and deposit geography concerns. Therefore, this mitigation measure was eliminated from further consideration.
TBM-26	Groundwater discharge of treated water	Yes	Yes	Yes	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, no viable locations were found within the Project area. Therefore, this mitigation measure was eliminated from further consideration.

Mitigation Measure Number	Potential Mitigation Measure	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Regulatorily Feasible	Rationale
TBM-27	Co-disposal of tailings in surface and subaqueous waste rock facilities at the Mine Site	Yes	Yes	Yes	Yes	This mitigation measure would address all four issues identified in the Tailings Basin mitigation process; however, this measure was also evaluated during the scoping phase of the EIS and eliminated because off-site pits were either unavailable or did not provide sufficient capacity. Therefore, this mitigation measure was eliminated from further consideration
TBM-28	Chemical Modification of the Hydromet cell sulfates	Yes	Yes	Yes	Yes	This mitigation measure would only address the sulfate-related issues (wild rice and methylmercury) identified in the Tailings Basin mitigation process. It was determined that this measure would affect less than 10% of the sulfate load from the Project and would not be an efficient measure to address sulfate. Therefore, this mitigation measure was eliminated from further consideration.

Source: MnDNR and ERM 2009,d*raft NorthMet Tailings Basin Mitigation Screening Table ERM 052809 rev 2*..

Table 3.2-3 Screening of NorthMet Individual Mitigation Measure Combinations

Combination Number	Individual Mitigation Measures Incorporated into the Combination	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Regulatorily Feasible	Rationale
Combinations Evaluated in the DEIS						
C-9F	**Operations:** Vertical Wells pump seepage from the embankment into pond Permeable Reactive Barrier demonstration test with or without the contingency water treatment plant **Post-Closure:** If PRB test was not effective, vertical wells may pump collected seepage to Partridge River downstream of Colby Lake with or without the water treatment plant (TBM-1) If PRB test was effective, install the PRB at north of the Tailings Basin (TBM-17) Increased Rock Buttresses (TBM-6)	Yes	Yes	Yes	Yes	This Combination was carried forward in the DEIS as the Tailings Basin Alternative. It is technically, economically, and regulatorily feasible; however, the technical feasibility assumes the contingent waste water treatment plant is incorporated.
Potentially Viable Combinations not Evaluated in the DEIS						
C-2B	Partial Liner (TBM-11), Partial Dry Cap (TBM-7), Increased Rock Buttresses (TBM-6), and Groundwater flows to wetlands	Yes	Yes	Yes	No	Combination 2B would result a minimal improvement in methylmercury concentrations during the Post-Closure period. Therefore, the long-term benefits of Combination 2B for sulfate levels would be less than Combination 9F.
C-4	Physical Barrier (TBM-2), Direct Piping of Leachate to the Partridge River (TBM-9), Wet Cap (Proposed Action), Water Treatment	Yes	No	Yes	No	The physical barrier (TBM-2) in Combination 4 would result in too much groundwater drawdown in wetlands north of the Tailings Basin.
C-5	Physical Barrier (TBM-2), Dry Cap (TBM-7), Pump to Area 5 Pit, PRB test at the Railroad Crossing, Discharge to Embarrass River; plus Increased Rock Buttresses (TBM-6)	Yes	Yes	Yes	No	The physical barrier (TBM-2) in Combination 4 would result in too much groundwater drawdown in wetlands north of the Tailings Basin.
C-7	Permeable Reactive Barrier (TBM-17), Dry Cap (TBM-7), Groundwater flows to wetlands; plus Rock Buttresses (TBM-6)	Yes	No	Yes	No	Trial results of this Combination (Minntac) showed increased methymercury and it was determined that no other trial results were available. The potential sulfate reduction data from the Minntac trial were not well-supported.
C-8	Paste or Thickened Tailings (TBM-4), Vegetative Cover, Groundwater flows to wetlands north of the Tailings Basin	Yes	Yes	No	Yes	The use of paste or thickened tailings would have technical challenges related to deposition and hardening in the cold climate of the Project Area.

Combination Number	Individual Mitigation Measures Incorporated into the Combination	Meet the Purpose and Need	Technically Feasible	Economically Feasible	Regulatorily Feasible	Rationale
C-9B	Vertical Wells at the toe (during operations & possibly Post-Closure), Dry Cap (TBM-7), Pump to Area 5 Pit, PRB test, Discharge to Embarrass River; plus Increased Rock Buttresses (TBM-6)	Yes	Unknown	Yes	No	This Combination would address methylmercury in wetlands; however, it would not address methylmercury in lakes downstream of the Tailings Basin.
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 River, PRB north of the Tailings Basin (during Post Closure) and Groundwater flow north to wetlands; Increased Rock Buttresses (TBM-6)	Yes	Yes	Yes	No	This Combination is considered “high-risk” because it would increase the methylmercury potential to downstream lakes and rivers.
Combinations Eliminated from Consideration						
C-1	Partial Liner (TBM-11), Wet Cap (Proposed Action), Water Treatment (long term), Direct Piping of Leachate to the Partridge River (TBM-9)	Yes	Yes	Yes	No	This Combination would require long-term treatment and was therefore eliminated from further consideration.
C-3	Physical Barrier (TBM-2), Wet Cap (Proposed Action), Direct Piping of Leachate to the Partridge River (TBM-9)	Yes	Yes	Yes	No	It was determined that this Combination would not change sulfate levels in the river and would be minimally effective overall; therefore, it was eliminated from further consideration.
C-6	PRB (TBM-17), Wet Cap (Proposed Action), Groundwater Flows to wetlands; Increased Rock Buttresses (TBM-6)	Yes	No	Yes	No	It was determined that the wet cap does not offer sufficient protection and the Permeable Reactive Barrier (TBM-17) technology is unproven. Therefore, this Combination was eliminated from further consideration.

Source: MnDNR and ERM 2009,d*raft NorthMet Tailings Basin Mitigation Screening Table ERM 052809 rev 2.*.

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 3.2-4 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 and would be environmentally preferable to developing a greenfield site. Off-site subaqueous disposal of waste rock was considered; however, the proposed on-site subaqueous disposal would provide similar environmental benefits 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 pits. However, the Area 5 pit would not have enough capacity for all tailings produced; therefore a tailings 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 all waste rock would be reactive; therefore this alternative does not apply to the Project.

Table 3.2-4 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 would be no “non-reactive waste rock.”
E2	Offsite, in-pit subaqueous 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 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 subaqueous 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, 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, 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.[22]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[22] 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 been 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 would 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 (until the West Pit overflows), but rather collects this water for beneficial reuse at the Processing Plant. In addition, the treatment plants did not have enough capacity to handle the projected volume of water.
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. In addition, the treatment plants did not have enough capacity to handle the projected volume of water.
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 (Babbitt 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 stormwater 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 stormwater 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 Site alternative already under consideration that would still allow future ore recovery in West Pit.

Modified Scale or Magnitude							
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 metal extraction technologies would not have significant environmental benefits over the proposed hydrometallurgy technology. The following analysis is included in response to public inquiries regarding the feasibility of underground mining the NorthMet deposit.[23]

The ability to mine ore using underground methods is largely dependent on the geometry and depth 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 (also known as subsidence), 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, Inc. 2009, *Memorandum*). 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 3.2-5.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[23] Tribal cooperating agencies disagree with the rationale used to eliminate underground mining as an alternative. See table 3.2-4 for details.

Table 3.2-5 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 Proposed Action.

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 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 co-disposal of reactive waste rock and tailings on a lined tailings basin was eliminated as a stand alone treatment since it would not likely eliminate the need to collect and treat stockpile drainage. The chemical modification of reactive waste rock was carried forward in the analysis as a mitigation measure (Table 3.2-4).

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 3.2-4.

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 affect 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. 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 groundwater or discharges to surface water) Project operations through Post-Closure to evaluate Project effects on both surface and groundwater quantity and quality. A "roadmap" to the Water Resources section (Table 4.1-1) is provided below that guides the reader to the pages where key water resources topics are discussed.

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	4.1-3	4.1-59	Same as EC	Same as PA	Not applicable
Groundwater quality at Mine Site	4.1-8	4.1-65	Same as EC	4.1-136	Not applicable
Flows in the Upper Partridge River	4.1-20	4.1-98	Same as EC	Same as PA	Not applicable
Water quality in Upper Partridge River	4.1-33	4.1-108	Same as EC	4.1-141	Not applicable
Water levels in Colby Lake & Whitewater Reservoir	4.1-24	4.1-104	Same as EC	Same as PA	4.1-153
Water quality in Colby Lake & Whitewater Reservoir	4.1-36	4.1-115	Same as EC	4.1-141	Not applicable
Flows in the Lower Partridge River	4.1-27	4.1-106	Same as EC	Same as PA	4.1-154
Water quality in Lower Partridge River	4.1-39	4.1-117	Same as EC	4.1-141	4.1-155
Groundwater levels downgradient of Tailings Basin	4.1-6	4.1-63	4.1-130	Not applicable	4.1-149
Groundwater quality downgradient of Tailings Basin	4.1-11	4.1-86	4.1-130	Not applicable	4.1-149
Flows in the Embarrass River	4.1-27	4.1-106	4.1-132	Not applicable	4.1-156
Water quality in Embarrass River	4.1-40	4.1-117	4.1-132	Not applicable	4.1-157
Waters That Contain Wild Rice	4.1-44	4.1-120	4.1-132	4.1-145	4.1-159
Mercury in Water	4.1-48	4.1-122	4.1-133	4.1-145	4.1-161
Impact Summary Table	Not applicable	4.1-129	4.1-133	4.1-146	4.1-162

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).

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.[1]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] It is the position of the tribal cooperating agencies that 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 piezometers 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.

Geology and 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

Aquifer	Test methods	Hydraulic Conductivity: Range	Hydraulic Conductivity: Geometric Mean	Reference
Surficial	Lab permeability tests on silty sand samples	4.3×10^{-4} ft/day to 8.1×10^{-3} ft/day	NA	Appendix B in RS22B, Draft 03, Barr 2008
	Single-well tests of various unconsolidated deposits	1.2×10^{-2} ft/day to 3.1×10^{1} ft/day	NA	Appendix B in RS22B, Draft 03, Barr 2008
Duluth Complex	Single-well aquifer tests on 10 exploratory borings	2.6×10^{-4} ft/day – 4.1×10^{-2} ft/day	2.3×10^{-3} ft/day	RS02, Barr 2006
Virginia Formation - Upper Portion	4 pumping wells and 5 observation wells	2.4×10^{-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). 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% of the surficial cover at the Mine Site is 20 feet thick or less, and 92% 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, available soil mapping, and field investigations most of these wetlands are bogs, which are characterized by a waterlogged organic soil body perched over dense clayey till or a more localized sandy surficial aquifer (RS44, 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.[2] There are other wetland communities present at the Mine Site, such as shrub swamps, forested swamps, and wet/sedge meadows that may receive some portion of its hydrology from groundwater. The remaining shallow marsh communities generally result from artificial impoundment by beaver dams, roads, and railroads and is primarily dependent on surface waters for hydrology.

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 (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.[3]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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 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.

[3] 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). Near the toe of the Tailings Basin, average depth to bedrock is approximately 25 feet as reported in site boring logs (Barr 2009, *Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation*). The area farther 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).

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 some 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 an estimated recharge rate of approximately 0.3 inches per year (Barr 2009, *Technical Memorandum: Results of Tailings Basin Hydrogeological Investigation*).[4]

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[4] Tribal cooperators note that hydrologic data indicates that this aquifer is saturated by tailings discharge water. 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 closed and 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 seepage rate 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 Tailings Basin into the surrounding unconsolidated deposits to the south, west, and north. Current groundwater seepage from the LTVSMC Tailings Basin to the north toward the Embarrass River is estimated at approximately 1,795 gpm (Hinck 2009, Personal Communication). This seepage rate 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 approaching 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 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 Waters). The State of Minnesota has adopted (*Minnesota Rules*, part 7050.0220, subpart 2) the USEPA primary and secondary drinking water standards (40 CFR part 141 and 143) and established Health Risk Limits (*Minnesota Rules*, part 4717.7500), which collectively serve as the state's groundwater quality standards (Table 4.1-4). The USEPA primary drinking water standards, or maximum contaminant levels (MCLs), have been established to protect the public against consumption of water that present a risk to human health. The secondary drinking water regulations 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.

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, 2006, and 2009, 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 with a maximum concentration of 0.13 nanograms per liter (ng/L). The metals exceeding groundwater evaluation criteria in the surficial aquifer probably reflect natural conditions because there is no record of any historic activities at the Mine Site that could have contributed these constituents.

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 7,190 µg/L), as well as sulfate, cadmium, 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	--
pH	s.u.	--	--	6.5 to 8.5
Sulfate	mg/L	--	--	250
Total Dissolved Solids	mg/L	--	--	500
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	--
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]	ng/L	2,000	--	--
Nickel (soluble salts)[6]	µg/L	--	100	--
Selenium	µg/L	50	30	--
Silver	µg/L	--	30	100
Thallium (salts)[6]	µg/L	2	0.6	--
Vanadium	µg/L	--	50	--
Zinc	µg/L	--	2,000	5,000

Source: Primary MCL (40 CFR part 141); secondary MCL (40 CFR part 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 MDH Health Risk Limit is based on the salt form of this parameter. It is conservatively assumed, for purposes of this DEIS, that the salt form is equivalent to the total concentration of this parameter.

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		Bedrock Aquifer			
							Northeast MN Baseline	Cu-Ni Study Baseline				
			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	--	--	4 of 16	0.3	<0.1 to 1.9	NA
Calcium	mg/L	--	6 of 6	15.8	7.1 to 30.1	NA	0.2 to 115	--	16 of 16	16.2	5.4 to 38.5	NA
Chloride	mg/L	250	6 of 6	1.81	0.69 to 5.5	0	0.4 to 19	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	5.6	2.3 to 6.8	NA	0.1 to 326	--	15 of 16	9.1	<2 to 21.4	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	6.0 to 9.8	**5**
Sulfate	mg/L	250	6 of 6	14.0	10.4 to 21.2	0	<0.3 to 14.2	1.8 to 450	14 of 15	96.8	4.4 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 30	0.0 to 200	9 of 16	**2,759**	<25 to 39,900	**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	0 of 16	<0.2	<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	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	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 9.5	0
Manganese	ug/L	50	5 of 6	**230**	<30 to 584	**5**	0.9 to 1,248	10.0 to 7,190	12 of 16	**72**	<10 to 383	**5**
Mercury	ng/L	2,000	3 of 4	13.6	<2.0 to 28.8	0	--	--	4 of 12	1.1	<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 16	6.8	<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]	<0.005 to 0.01	--	0 of 16	<2	<2	BDL[2]
Zinc	ug/L	2,000	2 of 6	21	<10 to 46.3	0	<2.7 to 138	3.9 to 170	7 of 16	39	<10 to 125	0
Dissolved/Filtered Metals												
Aluminum	ug/L	50 to 200	5 of 6	**304**	<25 to 910	**4**	--	--	3 of 16	36	<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.
Values in **bold** exceeds evaluation criteria.

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 aluminum, iron, and 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 sulfate were detected. Ammonia was detected in two samples, which is unusual as ammonia is not typically found in bedrock aquifers. The presence of ammonia in these two samples is attributed to either collection or laboratory error as both samples were collected on the same day and both were from 6-inch diameter boreholes that had collection difficulties (RS02, Barr 2006). Further, there was no nitrite or nitrate found. These are the forms of nitrogen to which ammonia quickly converts. The lack of any nitrite or nitrate indicates the ammonia was recently introduced and there is no on-going source of ammonia.

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 baseline 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>Baseline Water Quality</u>

At the baseline well (GW-002), groundwater within the surficial aquifer has elevated concentrations (i.e., at or higher than the groundwater evaluation criteria) of 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 Baseline GW-002 Surficial Aquifer				Northeast MN Baseline Surficial Aquifer	Copper-Nickel Study 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 0.57	--
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 30	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)]	<0.01 to 0.41	--
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	0.09 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**	0.9 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	<4.2 to 12	--
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	<0.01 to 0.05	--
Thallium	ug/L	0.6	0 of 3	<0.4	<0.4	0[(2)]	<0.005 to 0.01	--
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	**64**	<25 to 110	**2**	--	--
Arsenic	ug/L	10	0 of 1	<2	<2	0	--	--
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 2	3.9	3.1 to 4.7	0	--	--
Manganese	ug/L	50	11 of 14	44.7	<10 to 267	**2**	--	--
Nickel	ug/L	100	2 of 2	1.8	<1.5 to <2	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). Table 4.1-7 summarizes the results of surface water quality monitoring of the Cell 2E pond (mean values for data collected from 2001 to 2004) and groundwater quality monitoring at several monitoring wells located along the northern toe of the Tailings Basin. The LTVSMC

Tailings Basin 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 comparison of these data with surface or groundwater standards is not appropriate, but these standards are listed for informational purposes.

Table 4.1-7 Summary of Existing Pond Water and Groundwater Quality at the Tailings Basin

Constituent	Units	Pond Water Quality	Toe of Tailings Basin (GW-001,GW-006, GW-007, GW-008, GW-012 Surficial Aquifer)			
General Parameters		**Mean**	**Groundwater Evaluation Criteria**	**Detection**	**Mean**[1]	**Range**
Calcium	mg/L	30	--	16 of 16	72	23 to 132
Chloride	mg/L	23	250	113 to 113	1.7	0.5 to 34
Fluoride	mg/L	5.2	2	93 of 114	1.3	<0.1 to 9.6
pH	s.u.	8.4	6.5 – 8.5	117 of 117	7.4	6.2 to 9.1
Sulfate	mg/L	109	250	114 of 114	155	13.4 to 555
Total Dissolved Solids	mg/L	381	500	97 of 97	576	49 to 1,400
Metals – Total						
Aluminum	ug/L	--	50 - 200	11 of 15	1,080	<25 to 6,600
Antimony	ug/L	--	6	0 of 15	<0.5	<0.5
Arsenic	ug/L	5.0	10	6 of 15	3.0	<0.5 to <10
Barium	ug/L	--	2,000	13 of 14	116	<10 to 300
Beryllium	ug/L	--	0.08	0 of 15	0.9	<0.2 to <2.0
Boron	ug/L	278	1,000	40 of 49	301	<35 to 588
Cadmium	ug/L	--	4	1 of 15	0.5	<0.2 to <2.0
Chromium	ug/L	--	100	2 of 11	2.5	<1.0 to 9.5
Cobalt	ug/L	1.0	--	16 of 16	1.8	0.22 to 5.0
Copper	ug/L	2.0	1,000	12 of 13	3.9	0.7 to 13
Iron	ug/L	--	300	15 of 15	4,248	72.2 to 14,000
Lead	ug/L	--	15	4 of 15	1.1	<0.5 to 5.6
Manganese	ug/L	100	50	51 of 51	1,192	40 to 4,020
Mercury	ng/L	1.4	2,000	7 of 7	2.7	0.6 to 8.5
Mercury, Methyl	ng/L	--	--	0 of 6	0.07	<0.05 to <0.1
Molybdenum	ug/L	113	--	68 of 89	23.8	<1 to 94.8
Nickel	ug/L	2.1	100	11 of 11	5.9	2.1 to 11
Selenium	ug/L	--	30	2 of 15	1.6	<1.0 to <10
Silver	ug/L	--	30	0 of 15	<0.2	<0.2
Thallium	ug/L	--	0.6	0 of 15	<0.4	<0.4
Zinc	ug/L	--	2,000	3 of 13	16.8	<6.0 to 33
Dissolved/Filtered Metals						
Aluminum	ug/L	--	50 - 200	2 of 15	18	<10 to 25
Arsenic	ug/L	--	10	0 of 1	2	<2
Boron	ug/L	--	1,000	50 of 64	270	<35 to 540
Cadmium	ug/L	--	4	0 of 14	0.5	<0.20 to <2.0
Chromium	ug/L	--	100	3 of 15	1.5	<1.0 to 2.9
Copper	ug/L	--	1,000	11 of 16	61	<0.7 to 913
Manganese	ug/L	--	50	58 of 58	913	40 to 2,090
Nickel	ug/L	--	100	10 of 17	3.9	<2 to 8.1
Selenium	ug/L	--	30	0 of 15	<1.0	<1.0
Silver	ug/L	--	30	0 of 15	<0.2	<0.2
Zinc	ug/L	--	2,000	6 of 14	13	<6 to <30

Sources: Porewater, Barr 2009; *Memorandum: Water Quality Estimates for LTVSMC Tailings Basin Cell 2E and Cell 2W Seepage;* Pondwater - RS64, Barr 2006; Appendix H, RS74A, Barr 2008.

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.

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. Based on the parameters that were monitored in the Cell 2E pond, it appears that passage through the LTVSMC tailings reduces the average concentrations of arsenic, fluoride, and molybdenum, although it is difficult to discern to what extent these reductions are simply attributable to the effects of dilution. The concentrations of several other parameters, such as calcium, manganese, nickel, and total dissolved solids, increase as they seep from the tailings pond to the toe of the Tailings Basin.

The limited pond water quality data generally show elevated (relative to the groundwater evaluation criteria) fluoride concentrations, which 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.

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 elevated concentrations for several parameters (Table 4.1-7). As with the baseline 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 baseline well (GW-002, Table 4.1-6). 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).[5]

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 baseline 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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[5] 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.

In terms of the residential wells located farther from the Tailings Basin, the samples indicated that several wells exhibited manganese concentrations exceeding the groundwater evaluation criteria (i.e., secondary MCL). Localized high manganese concentrations can naturally occur under a range of conditions and these concentrations are within the range found in the Regional Copper-Nickel Study. One well had 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.

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 4	<0.1	<0.1	--	--	--	--	--
Calcium	mg/L	--	4 of 4	47	15.8 to 66	--	15 of 15	25	11.7 to 51.4	--
Carbon, total organic	mg/L	--	4 of 4	8.7	1.4 to 15.9	--	--	--	--	--
Chloride	mg/L	250	4 of 4	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	4 of 4	6.6	6.4 to 6.9	**1**	15 of 15	6.9	5.7 to 7.9	**4**
Sulfate	mg/L	250	4 of 4	109	20.8 to 235	0	11 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	4 of 4	**2,361**	25.3 to 9,140	**3**	2 of 15	30.2	<25 to 83	**1**
Antimony	ug/L	6	0 of 4	<0.5	<0.5	0	0 of 15	<0.5	<0.5	0
Arsenic	ug/L	10	0 of 4	<2	<2	0	3 of 15	2.8	<2 to 7.5	0
Barium	ug/L	2,000	4 of 4	195	37.9 to 442	0	--	--	--	--
Beryllium	ug/L	0.08	1 of 4	**0.24**	<0.2 to 0.34	**1**	--	--	--	--
Boron	ug/L	1,000	3 of 4	104	<50 to 150	0	3 of 15	79	<50 to 459	0
Cadmium	ug/L	4	1 of 4	0.3	<0.2 to 0.47	0	--	--	--	--
Chromium	ug/L	100	1 of 4	7.6	<1 to 27.3	0	--	--	--	--
Cobalt	ug/L	--	4 of 4	6.2	1.2 to 13.5	--	--	--	--	--
Copper	ug/L	1,000	4 of 4	6.0	1.2 to 17.9	0	13 of 14	38	<0.7 to 155	0
Iron	ug/L	300	4 of 4	**4,743**	63.2 to 14,700	**3**	--	--	--	--
Lead	ug/L	15	2 of 4	1.2	<0.5 to 3	0	--	--	--	--
Manganese	ug/L	50	4 of 4	**1,637**	226 to 2,990	**4**	15 of 15	**579**	0.66 to 4,710	**7**
Mercury	ug/L	2	1 of 1	**16.2**	16.2	**1**	--	--	--	--
Mercury, Methyl	ng/L	--	0 of 1	<0.1	<0.1	--	--	--	--	--
Molybdenum	ug/L	--	4 of 4	5.1	1.2 to 9.2	--	12 of 15	0.6	0.2 to 2.8	--
Nickel	ug/L	100	4 of 4	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 4	<1	<1	0	--	--	--	--
Silver	ug/L	30	0 of 4	<0.2	<0.2	0	--	--	--	--
Thallium	ug/L	0.6	0 of 4	<0.4	<0.4	0	--	--	--	--
Zinc	ug/L	2,000	0 of 3	<6	<6	0	--	--	--	--
Dissolved/Filtered Metals										
Aluminum	ug/L	50 - 200	0 of 4	<25	<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 4	<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 4	<1	<1	0	--	--	--	--
Silver	ug/L	30	0 of 4	<0.2	<0.2	0	--	--	--	--
Zinc	ug/L	2,000	0 of 3	<6	<6 to <6	0	--	--	--	--

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.

Legacy Groundwater Quality Issues at the Plant Site and Tailings Basin

In 2002, Cliffs Erie LLC commissioned a Phase I Environmental Site Assessment 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 LTVSMC and continued 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.

Cliffs Erie LLC received 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).

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 Areas of Concern Status

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

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 showed no evidence of any organic contamination leaving the site (Cliffs Erie 2009). Based on the investigations and laboratory analyses to date, which includes sampling at 7 monitoring wells, 14 surface discharges, 12 internal waste streams, 6 downstream surface water monitoring stations, and visual observation and limited field analyses at 33 seeps at or near the LTVSMC Tailings Basin, there has not been any documentation of any off-site contamination, and the extent of on-site contamination from the legacy sites appears to be limited to localized soils and possibly groundwater.[6]

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 from MnDNR for mine pit dewatering in the Project area, including the Peter Mitchell Mine (Permit 1982-2097), which authorizes Northshore Mining Company to withdraw up to 36,000 gpm (~80 cfs), of which a maximum of 23,000 gpm (51 cfs) can be discharged to the Dunka River watershed and a maximum of 13,000 gpm (29 cfs) can be discharged to the Partridge River.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[6] 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 throught 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 4.1-11 Existing Domestic Wells Located Between the Proposed NorthMet 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 water bodies draining the Project and both are tributaries to the St. Louis River (Figure 4.1-1). This section describes the existing hydrology and water quality of these two rivers and other potentially affected streams in the Project area.

Hydrology

Partridge River

The Partridge River forms just south of the Peter Mitchell Mine (although historically its 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 (Table 4.1-12). 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. For purposes of this DEIS, the Partridge River upstream of Colby Lake is referred to as the Upper Partridge River, while the segment downstream of Colby Lake is referred to as the Lower Partridge River.

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).[7]

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 (Brooks 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 the 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.[8]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[7] It is the tribal cooperating agencies' position that the baseline data for both the Mine Site and the Tailings Basin are inadequate. 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. Tribal cooperating agencies have requested that additional data be collected.

[8] 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.

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:	106.0 mi^2			29.0 mi^2			161.0 mi^2		
Contributing Drainage Area:	100.0 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	116(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.

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.

The survey results indicated that 54% of the Partridge River is a Type C channel, 31% is a Type E channel, and 13% 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 stream banks 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, Figure 4.1-11) may be attributable to pit dewatering discharges from the Peter Mitchell Mine (maximum permitted discharge rate of 29 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 (a 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 and surface water withdrawals from 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 Water Appropriation 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 5SW 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 at 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 (MN0000990 SD-001) to the downstream portion of the lake (Figure 4.1-13), but there is up to a 4.2 cfs evaporative loss of water from the cooling tower (Table 4.1-14).

Table 4.1-14 Discharges to and Surface Water Withdrawals from the Partridge River Watershed

NPDES Permit Number	Discharge ID	Outfall Description	Receiving Waters	Flow (cfs)	
				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	7.8	11.1
	SD-006	Pit 6 dewatering pipe	Second Creek	15.5	22.3
	SD-007	Pit 9S dewatering pipe	First Creek	16.7	22.3
	SD-014	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	SD-015	Pit 2WX dewatering pipe	Second Creel (via wetlands)	7.8	11.2
	SD-016	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	SD-017	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	SD-018	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	SD-019	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	SD-020	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	SD-021	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	SD-023	Pit 9S dewatering pipe	First Creek	16.7	22.3
	SD-024	Pit 6 dewatering pipe	First Creek	--	11.2
MN0042536 Cliffs Erie LLC	SD-008	Pit 2W dewatering pipe	Second Creek	7.8	11.2
	SD-009	Pit 2W dewatering pipe	Second Creek	7.8	22.3
	SD-010	Pits 2/2E/3 dewatering pipe	Wetland to Wyman Creek	7.8	11.2
	SD-011	Pits 2/2E/3 dewatering pipe	Wetland to Wyman Creek	7.8	11.2
	SD-012	Pit 3 overflow channel	Wyman Creek	7.8	11.2
	SD-013	Pit 2W dewatering pipe	Tributary to Colby Lake	11.1	22.3
	SD-026	Cell 1E seepage/stormwater	Second Creek	0.6	1.4
	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	2.3	9.0
MN0046981 Northshore Mining Co. Peter Mitchell Mine	SD-006	185S pit dewatering	Partridge River headwaters	Inactive	50.8
	SD-007	223S pit dewatering	Partridge River headwaters	Inactive	50.8
	SD-008	258S pit dewatering	Partridge River headwaters	Inactive	50.8
	SD-009	280/292S pit dewatering	Partridge River headwaters	11.5	50.8
	SD-010	360S pit dewatering	Partridge River headwaters	0.3	50.8
	SD-011	380S pit dewatering	Partridge River headwaters	Inactive	50.8
	SD-012	430S pit dewatering	Partridge River headwaters	Inactive	50.8
	SD-013	Crusher 2 sanitary outfall	Partridge River headwaters	Inactive	0.07
	SD-016	Crusher 2 area discharge	Partridge River headwaters	0.01	0.14
MN0020206 Hoyt Lakes WWTP	SD-002	Main Facility Discharge	Whitewater Reservoir	0.39	1.1
MN0000990 MN Power Laskin Energy Center	SD-001	Main Discharge	Colby Lake	194	212
	SD-002	Ash Pond Discharge	Colby Lake	0.6	2.2
Water Appropriation				**Flow (cfs)**	
Permitee	**Permit Number**	**Intake Description**	**Water Source**	**Avg.**	**Max.**
MN Power/Cliffs Erie LLC	1949-0135	Mining process water	Colby Lake	--	33.5[(2)]
MN Power (Laskin)	1950-0172	Cooling Water	Colby Lake	--	224[(3)]
Hoyt Lakes	1954-0036	Municipal Water Supply	Colby Lake	0.6	2.3[(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 26.8 cfs for any continuous 60-day period.

3 Includes a maximum 4.2 cfs consumptive use for evaporative losses.

4 Represents instantaneous peak withdrawal, permit also includes an annual maximum withdrawal rate of 0.7 cfs.

Around 1955, in order to assure a reliable source of water, Erie Mining Company (precursor to 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 (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.

After closure of the LTVSMC mine and processing plant in 2001, Minnesota Power purchased the Diversion Works and most 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-permittee and enable PolyMet to obtain makeup water from Colby Lake for use at the Plant Site, subject to MnDNR approval at the time of permitting.

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 higher average water levels (Table 4.1-16).

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[2] (with LTVSMC withdrawals)	Actual measurements	4.1 ft	24.1%
1978-1988	During mining[2] (with LTVSMC withdrawals)	Modeled predictions	5.6 ft	25-27%
2001-2006	During mining[2] (without LTVSMC withdrawals)	Actual measurements	3.7 ft	7.5%

Source: RS73B, 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.

2 Includes effects of Northshore Mining operations from 1955 to present.

Table 4.1-16 Comparison of Whitewater Reservoir Elevations over Time

Time Period	Represent	Source	Max Annual Fluctuation[1]	Average Water Elevation
1937 - 1954[(3)]	Pre-mining	Actual measurements	2.0 ft	Not Applicable
1955 - 1980	During mining[2] (with LTVSMC withdrawals)	Actual measurements	14.3 ft	1,437.7 ft
2002 - 2008	During mining (without LTVSMC withdrawals)	Actual measurements	4.5 ft	1,438.0 ft

Source: Actual measurements taken from MnDNR website (Lake Finders). No data was available between 1980 and 2001.

1 Maximum annual fluctuation is the maximum difference between annual maximum and minimum water elevations for any single year during the indicated time period.

2 Includes effects of Northshore Mining operations from 1955 to present.

3 Pre-1955 data is for Partridge Lake. Construction of Whitewater Reservoir, which raised the elevation of Partridge Lake, was not completed until 1955.

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 of surface 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 (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 seepage drains to the Embarrass River.

There are two USGS gaging stations located within the Embarrass River watershed (#04017000 located about three miles northwest of the Tailings Basin and #04018000 located about seven miles southwest of the Tailings Basin). Table 4.1-17 provides flow data for the nearest gaging station at Embarrass (Figure 4.1-1 for location).

Table 4.1-17 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 collected data from 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., average annual 1-day maximum flow) flows at this station as 1.2, 13.8, and 144.4 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 farther downstream in the Embarrass River, as shown in Table 4.1-18 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 4.1-18 NPDES/SDS Discharges to the Embarrass River Watershed

NPDES/SDS Permit Number	Permit Number	Outfalls ID	Outfall Description	Receiving Waters	Flow (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[(2)]	
Mesabi Mining LLC	MN0069078	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.
2 Subsequent monitoring indicators average flow is approximately 1.99 cfs.

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, total surface 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 surface seepage from the Tailings Basin as 1.8 cfs (800 gpm) (NTS 2009). Table 4.1-19 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, surface 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 (2.0 cfs from Cells 1E/2E and 2.0 cfs from Cell 2W) (Barr 2008, *External Memorandum: Changes to the Tailings Basin Flows in the Embarrass River Watershed*).

PolyMet has collected data from a second surface water monitoring station (PM-13), as shown in Figure 4.1-1 along the Embarrass River just downstream of the Heikkilla 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., average annual 1-day maximum flow) flows at this station as 9.7, 85.5, and 857.1 cfs, respectively (Barr 2008, *External Memorandum: Changes to the Tailings Basin Flows in the Embarrass River Watershed*).

Table 4.1-19 Summary of Existing LTVSMC 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 4.1-20. 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, 4A, 4B, 5, and 6; 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), 3B (industrial consumption-moderate treatment), 3C, 4A, 4B, 5 and 6 (*Minnesota Rules*, part 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.

In *Minnesota Rules*, part 7050.0221, the USEPA primary and secondary drinking water standards are adopted for Class 1B waters (treated with simple chlorination for domestic consumption). The USEPA primary drinking water standards (40 CFR part 141) set mandatory MCLs for drinking water contaminants to protect the public against consumption of water that present a risk to human health. The USEPA has also established secondary drinking water standards (40 CFR part 143) for 15 contaminants, which are intended 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 4.1-20 presents the surface water quality standards for the stream classifications applicable to the NorthMet Project. *Minnesota Rules*, part 7050.0224 subpart 2 also addresses water quality as it relates to wild rice as follows:

> *"The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area, including truck garden crops. The following standards shall be used as a guide in determining the suitability of the waters for such uses…:*
>
> *Sulfates (SO_4) – 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels."*

Table 4.1-20 Surface Water Quality Standards Applicable to the NorthMet Project

Parameter	Units	Class 1B Primary MCL	Class 1B Secondary MCL	Class 2B[3]	Class 2Bd[3]	Class 3B[4]	Class 3C[4]	Class 4A[5]	Class 4B[5]	Class 5	Class 6
General											
Chloride	mg/L	--	250	230	230	100	250	--	--	--	--
Dissolved Oxygen	mg/L	--	--	> 5.0	>5.0	--	--	--	--	--	--
Fluoride	mg/L	4	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	--
Specific Conductance	mg/L	--	--	--	--	--	--	--	1,000	--	--
Sulfate	mg/L	--	250	--	--	--	--	--[2]	--	--	--
TDS	mg/L	--	500	--	--	--	--	700	--	--	--
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	1,300	1,000	9.3[1]	9.3[1]	--	--	--	--	--	--
Iron	µg/L	--	300	--	--	--	--	--	--	--	--
Lead[5]	µg/L	15	--	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; and USEPA Primary MCL (40 CFR part 141); secondary MCL (40 CFR part 143)
All values represent total concentration unless otherwise noted.
(1) Based on *Minnesota Rules*, part 7052.0100 Water Quality Standards Applicable to Lake Superior Basin, which supersedes standards listed in part 7050. (2) The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels. (3) *Minnesota Rules*, part 7050.0222 and part 7052.0100. (4) *Minnesota Rules*, part 7050.0223. (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*, part 7050.0222 and 7052.0360.

Waters that contain wild rice are discussed later in this section of the DEIS.[9]

Because the Project is in the Lake Superior Basin, the Great Lakes Initiative (Lake Superior) water quality standards also apply (*Minnesota Rules*, chapter 7052). These Lake Superior standards can differ from the water quality standards for the same parameters in *Minnesota Rules*, chapter 7050. Where different, the 7052 standards supersede 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.

Upper Partridge River

Recent water quality data (collected by PolyMet in 2004, 2006, and 2007) 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 4.1-21. Most of these water quality data represent 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.

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 most of the St. Louis River is listed for "mercury in fish tissue" impairment.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[9] 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 if found. The PCA has used this approach in past permitting activities (MINNTAC Schedule of Compliance, 2008). The10 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.

Table 4.1-21 Available Surface Water Quality Monitoring Data in the Partridge River Watershed (see 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/SW-002	PolyMet/Cominco	1974-1976, 1978, 2001-2002, 2004
PM-3/CN126/S-1/SW-003	PolyMet/C-N Study/Kennecott	1974-1978, 2001-2004, 2006-2007
PM-16	PolyMet	2004, 2006-2007
PM-4/CN123/SW-005	PolyMet/C-N Study	1976-1977, 2004, 2006-2007
Colby Lake	C-N Study, USGS, MPCA, MN Power, Barr	1976-1977, 1988, 2001-2003, 2008
Whitewater Reservoir	MPCA	1972, 2001
USGS gage #04016000/CN122	C-N Study, USGS	1956-1966, 1976-1977, 1979
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, 2006-2007

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 (Siegel and Ericson 1980)

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 4.1-22). 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 exceedance of water quality standards was dissolved oxygen (DO) near the headwaters of the Partridge River (PM-2). Sufficient information is not available to interpret this exceedance, but the DO exceedances are localized and are not found at other upstream or downstream locations.

There are limited water quality data available from the mainstem of the Partridge River that predate the operation of the Peter Mitchell Mine in 1956 that can be used to characterize relatively "undisturbed" conditions. There are, however, six samples that were collected during the Copper-Nickel Study in 1976 and 1979 along the South Branch of the Partridge River at USGS Gaging Station #4015455 (Figure 4.1-1), which were unaffected by mining and most potential significant sources of contamination, that can provide some insights on "undisturbed condition" water quality in the Partridge River for several key parameters (Table 4.1-23). As these few samples indicate, water quality generally met water quality standards for the parameters monitored.

Table 4.1-22 Comparison of Historic and Recent Mean Water Quality Data for Selected Parameters at Common Monitoring Stations along the Partridge River

			S-4/PM-2/SW-002		CN126/PM-3/SW-003		CN123/PM-4/SW-005	
General Parameter	**Units**	**Stream Standard**	**1970's**	**2000's**	**1970's**	**2000's**	**1970's**	**2000's**
DO	mg/L	>5.0	6.7	5.0(1)	9.1	10.0	--	9.2
Hardness	mg/L	500	115	75(1)	117	81	85	63
pH	s.u.	6.0-9.0	7.0	6.8	7.3	7.4	7.2	7.8
Sulfate	mg/L	--	20.1	7.9(1)	18.9	8.3	18.9	7.2
Metals – Total								
Aluminum	µg/L	125	44	40(1)	76	54	123	116
Arsenic	µg/L	53	3.8	1.1(1)	3.2	1.1	0.8	1.0(1)
Cobalt	µg/L	5.0	0.6	0.1(1)	0.5	0.4	0.6(1)	0.7
Copper	µg/L	9.3(2)	1.3	1.1(1)	1.3	0.8	2.4	1.3
Iron	µg/L	--	1,085	1,603(1)	1,365	1,711	1,528	1,997
Lead	µg/L	3.2(2)	0.6	0.2(1)	0.8	0.2	0.7	0.7
Manganese	µg/L	--	112	168(1)	153	181	160	200
Nickel	µg/L	52(2)	1.4	0.4(1)	1.5	0.9	1.0(1)	1.5
Zinc	µg/L	120(2)	5.6	3.0(1)	4.4	7.7	2.0	10.2

Source: RS76, Barr 2007
1 Based on less than five samples.
2 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

Table 4.1-23 Baseline Water Quality from the South Branch of the Partridge River[1]

Constituent	Units	Surface Water Standard	# of Samples	S. Branch Partridge R. Mean Concentration	S. Branch Partridge R. Range of Concentrations
General Parameters					
Chloride	mg/L	--	5	1.4	<0.1 to 3.2
Fluoride	mg/L	--	5	0.2	0.1 to 0.3
Hardness	mg/L	500	1	37	37
pH	s.u.	6.5 – 9.0	5	7.0	6.8 to 7.3
Sulfate	mg/L	--	5	5.2	1.4 to 8.9
Metals					
Aluminum	ug/L	125	2	150(2)	100 to 200
Arsenic	ug/L	53	2	<1.0	<1.0
Iron	ug/L	--	5	856	320 to 1,400
Manganese	ug/L	--	2	40	30 to 50
Mercury	ng/L	1.3	2	<500	<500

Source: www.pca.state.mn.us//data/edawater/index.cfm
1 Based on water quality monitoring data from 1976 and 1979
2 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

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 4.1-24).

Table 4.1-24 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							
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	0.09	0.09	0.09
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	17.3	45.9	60.3	71.3	116[(5)]
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	0.9	1.9	2.7	3.4	3.1
Nickel	µg/L	52[(3)]	1.5	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, RS74A, Barr 2008.
Note: Values in **bold** indicates an exceedance of surface water quality standard.
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).
5 Excludes single outlier value of 1,550 µg/L from values included in RS74A. This value (116 µg/L) was used in the surface water model calibration.

Colby Lake

Water quality in Colby Lake is affected by inflow from the upper Partridge River watershed, but also anthropogenic effects from mine pit dewatering and overflows (e.g., Peter Mitchell Mine in the headwaters; Pits 2/2E/2W/3/5S via Wyman Creek), two permitted discharges from Minnesota Power's Laskin Energy Center (e.g., cooling water discharge and a clarified ash pond discharge), pumping from Whitewater Reservoir during low flows, and stormwater runoff from the City of Hoyt Lakes.

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 4.1-25). 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, but is not included in Minnesota's regional mercury TMDL because the mercury concentrations in the fish are too high to be returned to Minnesota's mercury water quality standard through reductions in atmospheric mercury deposition alone. A TMDL study of Colby Lake is needed to determine what actions are required to reduce the mercury concentration in fish, but has not yet been performed.

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, but the available 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 4.1-25 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	mg/L	(2.0)[(2)]	5	0.1 to 0.7	10	0.3	0.1 to 0.4	--	--	--	3 of 5	1.1	0.1 to 1.4	0
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	0.9	0.8 to 1.0	--
Sodium	mg/L	--	4	3.6 to 4.3	10	6.3	4.7 to 8.0	--	--	--	5 of 5	3.2	2.9 to 3.5	--
Sulfate	mg/L	(250)[(2)]	15	8.7 to 140	14	52.9	8.7 to 140	--	--	--	5 of 5	17.1	10.1 to 31.7	0
Metals														
Aluminum	µg/L	50 to 200	5	180 to 470	10	307	180 to 610	12 of 12	171	61 to 264	5 of 5	208	179 to 243	**5**
Antimony	µg/L	5.5	--	--	--	--	--	0 of 3	3	<3	0 of 5	0.5	<0.5	0
Arsenic	µg/L	2.0	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	2,000	--	--	--	--	--	2 of 3	15.7	<10.0 to 29.1	5 of 5	6.9	5.7 to 7.6	0
Beryllium	µg/L	4.0	--	--	--	--	--	0 of 3	0.2	<0.2	0 of 5	0.2	<0.2	0
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	2.8	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	(300)[(2)]	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	**5**
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	(50)[(2)]	5	50 to 90	14	282	63 to 2,100	3 of 3	123	30 to 280	5 of 5	44	28 to 64	**1**
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	10	0.1 to 6.0	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	0.28	--	--	--	--	--	0 of 3	2.0	<2.0	1 of 5	0.41	<0.40 to 0.46	**1**
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.

2 Values in parentheses indicate secondary Maximum Containment Levels (sMCL)

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 are generally consistent with surface water standards with the exception of hardness and total dissolved solids (NTS 2009). Table 4.1-26 summarizes the surface water quality monitoring data for Station SD026.

Table 4.1-26 Summary of Surface Water Quality Monitoring Data for Station SD026

Constituent	Units	SD026 Surface Discharge (Seeps 32 and 33)		
General Parameters		**Detection**	**Mean**	**Range**
Calcium	mg/L	3 of 3	80.7	76.1 to 84.3
Chloride	mg/L	19 of 19	14.1	10.3 to 16.7
Fluoride	mg/L	35 of 35	2.9	1.5 to 4.2
Hardness	mg/L	27 of 27	530	192 to 648
pH	s.u.	62 of 62	8.0	7.0 to 8.5
Sulfate	mg/L	19 of 19	193	149 to 216
Total Dissolved Solids	mg/L	19 of 19	713	485 to 825
Metals – Total				
Aluminum	ug/L	--	--	--
Antimony	ug/L	--	--	--
Arsenic	ug/L	--	--	--
Barium	ug/L	--	--	--
Beryllium	ug/L	--	--	--
Boron	ug/L	33 of 33	250	158 to 304
Cadmium	ug/L	--	--	--
Cobalt	ug/L	0 of 14	3.8	<1 to <25
Copper	ug/L	--	--	--
Iron	ug/L	--	--	--
Lead	ug/L	--	--	--
Manganese	ug/L	33 of 33	535	110 to 1,520
Mercury	ng/L	9 of 14	1.0	<0.5 to <4
Molybdenum	ug/L	14 of 14	26.3	14.2 to 38.6
Nickel	ug/L	--	--	--
Selenium	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.

Periodic dewatering discharges from Pits 9/9S drain to First Creek and Pit 6 to Second 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 30.4 mg/L as it flows from Colby Lake to approximately 149 mg/L downstream of the confluence of First and Second Creek.

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, most of the St. Louis River is 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. These waters are not included in Minnesota's regional mercury TMDL because the mercury concentrations in the fish are too high to be returned to Minnesota's mercury water quality standard through reductions in atmospheric mercury deposition alone. A TMDL study of these waters is needed to determine what actions are required to reduce the mercury concentration in fish.

Water quality data (ranging from 1955 to 2007) are available for various parameters at three locations along the Embarrass River (Table 4.1-27). 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 4.1-27 Available Surface Water Quality Monitoring Data in the Embarrass River Watershed (see 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, 2006-2007
CN120	USGS/C-N Study	1955-1963, 1976-1977
PM-13 / SW-005	PolyMet / Cliffs Erie	2001-2005, 2004, 2006-2007
Tailings Basin		
PM-8 (SD006)	PolyMet	2004, 2006
PM-9 (SD001)	PolyMet	2004, 2006
PM-10 (SD002)	PolyMet	2004, 2006-2007
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 4.1-28 compares 1976 data from the Copper-Nickel Study with recent data from PolyMet for monitoring station CN121/SW-005/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 cobalt and manganese concentrations appear to be decreasing over time.

Table 4.1-28 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
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(3)
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 The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

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 (PM-12 and PM-13), as shown in Figure 4.1-1, along the Embarrass River (Table 4.1-29).

Pit 5NW (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 (Table 4.1-19 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 4.1-30). 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 ng/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 4.1-29). Significantly higher concentrations for several parameters, especially aluminum and sulfate are found at PM-13.

Table 4.1-29 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**(3)
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	--	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.

Note: Values in **bold** indicates an exceedance of surface water quality standards.

1 The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

2 Water quality standard for this metal is hardness-dependent. Listed value assumes a concentration of 100 mg/L.

3 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

Table 4.1-30 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	230 to 721	**9**	41 of 41	452	268 to 818	**11**	48 of 48	438	327 to 649	**7**	9 of 9	241	109 to 323	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	--	125 of 125	159	56.8 to 344	--	133 of 133	182	8.1 to 473	--	9 of 9	88	45.5 to 147	--
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]	4 of 4	39.3	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	<0.2	<0.2	0
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	415	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	81	40 to 180	--
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	4 of 9	2.7	0.7 to <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	2 of 9	14	<10 to 41	0

Source: RS76, Barr 2007; RS64, Barr 2006.

Note: Values in **bold** indicates an exceedance of surface water quality standards.

1 Minimum detection limit exceeds evaluation criteria; RS64, Barr 2006.

2 The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

3 Water Quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

4 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

Waters That Contain Wild Rice

Wild rice is an important resource in terms of its economic and environmental values, as well as having significant cultural value to the Ojibwe people. Current scientific understanding of its habitat requirements is limited. This section provides baseline information on the importance of wild rice, its habitat requirements, and presence within the Project area. Section 4.8 discusses the cultural importance of wild rice to the tribes in further detail.

Importance of Wild Rice

The Ojibwe people have a special cultural and spiritual tie to natural wild rice. Their Migration Story describes how they undertook a westward migration from eastern North America, which tribal prophets had foretold would continue until the Ojibwe people found "the food that grows on water" (Benton-Banai 1988). That food was wild rice, known as manoomin, and it is revered to this day by the Ojibwe as a special gift from the Creator. Natural wild rice remains a mainstay of traditional foods for the Ojibwe community and offers significant nutritional value. The tradition of hand harvesting natural wild rice continues to this day among both tribal and non-tribal cultures. It is estimated that more than 3,000 tribal members participate in wild rice harvesting statewide along with about 1,500 non-tribal individuals (MnDNR 2008).

Wild rice also represents an important food source for both migrating and resident wildlife. Wild rice has been listed as one of the 10 most important sources of food for ducks throughout the United State and Canada. In Minnesota, research conducted at Chippewa National Forest found that natural wild rice was the most important food for mallards during the fall, although many species of duck also use stands of wild rice. The stems of wild rice provide nesting material for several species and critical brood cover for waterfowl. The entire wild rice plant provides food during the summer for herbivores. In addition, rice worms and other insect larvae feed heavily on natural wild rice. These insects provide a rich source of food for various birds. In the spring, decaying rice straw supports a diverse community of invertebrates and thus provides an important source of food for a variety of wetland wildlife. As a result, many species of wildlife use wild rice lakes and streams for reproduction and foraging areas, including 17 species listed in MnDNR Comprehensive Wildlife Conservation Strategy (2006) as "species of greatest conservation need."

In addition to its importance for wildlife, natural wild rice also has other ecological values. Emergent aquatic plants like wild rice protect shorelines from erosion, provide habitat for fish, and temporarily sequester nutrients during the growing season, thereby reducing the potential for stream and lake eutrophication and turbidity.

Despite the advancement of cultivated wild rice, natural wild rice still remains an important component of tribal and local economies in Minnesota. For example, in 2007, nearly 300,000 pounds of unprocessed natural wild rice were purchased from the Leech Lake Band of Ojibwe-licensed harvesters generating more than $400,000 of income for tribal members (MnDNR 2008). As a commodity, unprocessed wild rice has recently had a value between $1.00 and $1.50 per pound.

Minnesota was the world's first producer of cultivated wild rice in the 1950s and remains one of the world's leading producers of cultivated wild rice, producing four to six million pounds annually (http://www.mnwildrice.org/facts.php). Cultivated wild rice, which depends on natural wild rice to an important degree in maintaining genetic diversity, plays an important role in Minnesota's rural economy. In 1992, the wild rice industry generates about $3.1 million in annual employee compensation, contributes $8.7 million in total employee payroll, and over $21 million in revenues to Minnesota's economy (Minnesota Cultivated Wild Rice Council 2008).

Preferred Habitat and Life Cycle

The historic range of natural wild rice is believed to have encompassed all of Minnesota (Moyle 1944), although it was most common in areas of glacial moraines in central and northern Minnesota. Based on a recent inventory, natural wild rice is still found in 55 counties in Minnesota (MnDNR 2008).

The distribution and abundance of natural wild rice is dependent on its habitat requirements as they relate to local environmental conditions (MnDNR 2008). These habitat requirements include:

- Surface water hydrology – some moving water, with rivers, flowages, and lakes with inlets and outlets being optimal areas for growth;
- Seasonal water depths – water levels that are relatively stable or decline gradually during the growing season are preferred, with optimal depths of 0.5 to 3.0 feet of water;
- Substrate – although wild rice may occur in a variety of lake bottoms, the most consistently productive stands are those with soft, organic sediments;
- Water clarity – clear to moderately colored (stained) water is preferred as darkly stained water can limit sunlight penetration and hinder early plant development; and
- Water chemistry – wild rice grows within a wide range of chemical parameters, however, productivity is highest in water with a pH of 6.0 to 8.0 and alkalinity greater than 40 mg/L. Wild rice stands require nitrogen and phosphorus, although excess levels of some nutrients, especially phosphorus, can adversely affect productivity. Some research has indicated that natural wild rice prefers low sulfate waters.

Wild rice is an annual plant that develops in the spring from a seed that drops off the plant to bottom sediments the previous fall. The seed requires a dormancy period of three to four months in 35 degrees Fahrenheit or colder water before germinating in the spring when water temperatures reach 40 degrees Fahrenheit. The plant goes through several distinct growth phases during its life cycle. During the submerged leaf stage in late May to early June, a cluster of underwater leaves forms. The floating leaf stage typically begins in mid-June as floating leaves develop and lay flat on the water surface and is when wild rice is most susceptible to being uprooted by rapidly rising water levels or high winds.

Aerial shoots typically begin to develop by the end of June and grow to a height of 2 to 8 feet above the water surface by August. Wild rice begins to flower in late July and the seeds develop in August and September. The wild rice seeds on the same plant mature across a staggered time period, ensuring that some seeds survive environmental conditions to perpetuate the stand. Some seeds may remain dormant in the bottom sediment for many years to several decades if conditions are not suitable for germination, allowing wild rice populations to survive through time periods with less than optimal conditions and reduced productivity. The time period from germination to dropping of mature seeds typically requires about 110 to 130 days, depending upon environmental conditions. Even under ideal growing conditions, wild rice stands undergo approximately 3 to 5 year cycles in which productivity varies. A typical cycle includes a highly productive year followed by a low productive year, which is followed by a gradual recovery.

There are two primary factors that can impact wild rice productivity – changes in hydrology and water quality. Wild rice typically occurs in shallow water and is sensitive to varying water levels, especially during the floating leaf stage in early summer when abruptly rising water levels can uproot the plant. Wild rice will stop growing if water becomes too deep (Fish & Wildlife Today, September/October 2001). A recent survey of wild rice harvesters (Norrgard et al. *Minnesota Natural Wild Rice Harvester Survey*, 2007), identified water level management as the highest management priority. MnDNR wildlife managers have hired trappers to remove beavers from some wild rice lakes to protect wild rice from rising water levels.

As mentioned above, some evidence suggests that increased sulfate concentrations could impact waters that contain wild rice. The specific impact of sulfate concentrations has not been clearly defined as it has been demonstrated that wild rice can grow in a range of sulfate concentrations (MnDNR 2008). Sulfate may retard the growth of wild rice at concentrations exceeding 50 mg/L. Other laboratory research, however, has suggested that a range of sulfate concentrations (2 to 400 mg/L) may be tolerated by wild rice. Results of laboratory bioassays performed by Lee (2000) suggest that wild rice seedlings developed normally in waters with sulfate concentrations up to 3,000 mg/L; abnormal growth appeared above this sulfate level. Field studies have variously reported natural wild rice growing in water with sulfate concentrations of 118 to 282 mg/L in Minnesota; between 105 and 575 mg/L in northern Saskatchewan (Peden 1982), and as high as 1,333 mg/L in Canada, but no information is provided regarding the health of the stands. Additional physiological research is needed to better understand the effect of sulfate on natural wild rice during various life stages.[10]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[10] It is the tribal cooperating agencies' position that 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.

Presence within the Project Area

The existing number, location, extent, and health of wild rice stands within the Partridge and Embarrass rivers is unknown. Along the Partridge River, there are no designated wild rice waters pursuant to *Minnesota Rules*, part 7050.0470 or identified in the *Natural Wild Rice in Minnesota* report (MnDNR 2008). Within the Embarrass River watershed, Hay Lake, which is located downstream of the Project on a tributary to the Embarrass River, is identified as a "wild rice water" in *Minnesota Rules* (Figure 4.1-1). In addition to Hay Lake, the *Natural Wild Rice in Minnesota* report included one other wild rice stand with no quantified acreage 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 at Fourth Lake, about 15 miles downstream from the LTVSMC Tailings Basin (Drotts 2009).

In response to a request by MPCA, PolyMet conducted a literature review of available historic and cultural information, including the *Natural Wild Rice in Minnesota* report, USGS topographic maps, and a wild rice list provided by the 1854 Treaty Authority; analyzed historic (2004 and 2008) infra-red aerial photographs; and consulted with persons and groups knowledgeable about wild rice to identify potential wild rice locations along the Partridge and, Embarrass rivers, including Spring Mine Creek, which is a tributary of the Embarrass River, and downstream on the St. Louis River, as well as Hay Lake and Little Rice Lake, which are not in the Embarrass or Partridge River watersheds, but were included as potential control sites for future monitoring of wild rice presence and health. Based on this analysis, field surveys were conducted in potential areas during August and September 2009 using a protocol adapted from the 1854 Treaty Authority. The location and both qualitative and quantitative estimates of density and crop acreage were recorded. Qualitative estimates recorded approximate stand density using a density factor with a scale of 1 (low density) to 5 (high density), similar to a method used by the 1854 Treaty Authority. Quantitative estimates of wild rice density and coverage were determined by sampling representative grids. Sulfate monitoring was also conducted during the wild rice survey (Barr 2009, Draft *Wild Rice and Sulfate Monitoring*). The location of wild rice identified during the field surveys along the Partridge and Embarrass rivers are summarized below and shown in Figure 4.1-15. The results of sulfate monitoring are shown in Figure 4.1-16.

The upper 13 miles of the Partridge River were inaccessible and not surveyed, but no wild rice was identified in this area from the literature or aerial photograph review. The field surveys found isolated patches of wild rice in the Upper Partridge River from RM13 to Colby Lake with a density factor of 1. No wild rice was found in Colby Lake. Stands with a density factor of 3 to 5 were identified along the Lower Partridge River between Colby Lake and approximately 0.5 miles downstream of County Road 110. Very little rice was found downstream of this point on the Partridge River.

The field surveys found only isolated patches of wild rice in the upper reach of the Embarrass River above the Embarrass River chain of lakes. Within the chain of lakes, wild rice was found in Sabin Lake, Wynne Lake, Lower Embarrass Lake, Unnamed Lake, Cedar Island Lake, Fourth Lake, Esquagama Lake and a 0.5 mile reach of the Embarrass River downstream from Esquagama Lake. The density factor was generally low (i.e., factor of 1), except for several stands in Cedar Island Lake, which had density factors ranging from 1 to 5. The headwaters of

Spring Mine Creek were not surveyed because of access issues, but the lower reaches were surveyed and no wild rice was observed. No rice was observed from downstream of Esquagama Lake between Routes 20 and 95. The Embarrass River downstream of Route 95 was inaccessible and not surveyed.

The results of the surveys along the St. Louis River are discussed in Section 4.1.4 Cumulative Effects.

Mercury in Water

PolyMet estimates that current total mercury concentrations average about 2.3 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 from 2007 to 2008. 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. PolyMet is conducting additional sampling in wetlands, streams, and downstream lakes in the Embarrass River watershed under an MPCA approved plan to help better understand mercury dynamics.

Mercury monitoring has occurred at the LTVSMC Tailings Basin and along the Embarrass River, which generally found mercury concentrations consistent with baseline levels (Table 4.1-31), 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 Minntac 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 baseline levels (Table 4.1-31), 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.

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 (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 LTVSMC plant closed in 2001. There are no significant surface water withdrawals or Water Appropriation Permits issued for the Embarrass River in the Project area.

Table 4.1-31 Summary of Total Mercury Concentrations at the Tailings Basin

			Mercury Concentrations			
Location[1]	**Dates**	**# of Detections**	**Mean (ng/L)**	**Range (ng/L)**	**# exceeding 1.3 ng/L(2)**	**# exceeding 10 ng/L(3)**
LTVSMC Tailings Basin Surface Water Seepage						
SD001/PM-9	2001-2006	12 of 65	1.8	0.7 – 4.1	6	0
SD002/PM-10	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/PM-8	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/PM-12	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.
1 Figure 4.1-7
2 Minnesota Class 2B Lake Superior standard for mercury.
3 Estimated average total mercury concentration in precipitation in Northern Minnesota (Berndt 2003; NCDC 2008).

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.

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.[11]

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. These surface water quality standards are listed in Table 4.1-20 and found in *Minnesota Rules*, parts 7052 and 7050. It should be noted, however, that the water quality standards for metals are expressed as total metals, in Table 4.1-20, but are applied as dissolved metal standards in surface waters (*Minnesota Rules*,

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[11] 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.

part 7050.0220). For most parameters, this distinction between total and dissolved concentrations is not significant, but it is for aluminum. Aluminum has very low solubility in water except under acidic conditions (pH <5.5) where it can become soluble and biologically available (USFWS 1996). Unfortunately, dissolved aluminum is rarely measured and most water quality data reports total aluminum. Since the typical pH for streams in the Project area is neutral (between 6.5 and 7.5), and not acidic, the dissolved aluminum concentrations are presumed to meet the surface water quality standard, even when the total aluminum concentration exceeds the (dissolved) standard. For purposes of this DEIS, aluminum is assumed to meet surface water quality standards unless acidic pH conditions are present.

Groundwater quality standards are USEPA primary (maximum contaminant levels) and secondary drinking water standards and MDH Health Risk Limits, which are listed in Table 4.1-4 and referenced in *Minnesota Rules,* part 7050.0221. The groundwater evaluation criteria, for purposes of this DEIS, are defined as including the USEPA primary MCLs, the MDH Health Risk Limits, and the USEPA secondary MCLs, with the exceptions of iron and manganese concentrations below the Health Risk Limit of 300 µg/L. These two parameters are excluded from the groundwater evaluation criteria because baseline concentrations for these two parameters in local groundwater already exceed USEPA secondary MCL standards, which is common throughout the Iron Range and Northeast Minnesota (Tables 4.1-5 and 4.1-6). As secondary MCLs, the USEPA standards for these two parameters (300 ug/L for iron and 50 ug/L for manganese) were developed for treated rather than natural water and were established only as guidelines by USEPA 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. The modeling predictions for iron and manganese will be presented in the DEIS, but elevated concentrations will not be identified as exceedances of groundwater evaluation criteria for the reasons discussed above.

The approach used in this DEIS compares predicted water quality with appropriate Minnesota surface water quality standards or groundwater evaluation criteria; and with existing conditions as determined by recent water quality monitoring.

4.1.2.3 Waters That Contain Wild Rice

MPCA has established the following approach for the evaluation and protection of waters that contain wild rice (Udd, MPCA, personal communication 2009):

> "*The goal of the MPCA is to protect those surface waters used for the production of wild rice. The quality of these waters shall permit their use for irrigation without significant damage or adverse effects upon any vegetation usually grown in the waters. The current state water rule establishes pollutant standards to be used as a guide for determining the suitability of waters for such uses, including the production of wild rice. When evaluating any facility or project with potential wild rice impacts, the MPCA will consider all available information to determine which surface waters are used for the production of wild rice. If any surface water is determined to be a wild rice water, the MPCA will evaluate whether there is a reasonable potential for the discharge(s) to cause or contribute to a violation of the applicable water quality standard. If a reasonable potential exists, then the MPCA will establish an appropriate water quality based effluent limit in the facility permit to protect the applicable water quality standard and the designated uses of the water as a wild rice production water.*"

4.1.2.4 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. However, Minnesota has fish tissue water quality standard for mercury of 0.2 mg/kg, which was amended to *Minnesota Rules*, chapter 7050 in 2008. 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 rules include a fish tissue water quality standard for mercury of 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 4.1-32). Based on the results of scientific investigations, this criterion assumes that all fish tissue mercury is in the methylmercury form (i.e., 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 4.1-32 Mercury Fish Consumption Advisory (MFCA) Concentrations

	Mercury Concentration in Fish (mg/kg, wet weight)			
MFCA for Mercury	<0.05	0.05 – 0.22	>0.2 – 0.95	>0.95
Consumption Advice[1]	Unlimited	1 meal/week	1 meal /month	Do not Eat

Source: *Minnesota Rules*, part 7050.0150

[1] Consumption advice for young children and women of child-bearing age.

Narrative Standards

Prior to the addition of the fish tissue water quality standard in 2008, the basis for assessing mercury contamination in fish tissue has been 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 or determine a single set of results.

Most of the results reported in this DEIS focus on conservative (i.e., low probability of occurrence, such as low flows) rather than average conditions. In some cases, especially where there was a high degree of uncertainty regarding key input assumptions to the deterministic models, probabilistic simulation, or Uncertainty Analysis, was also used to assess whether the deterministic modeling produced conservative values for the release of selected contaminants.

Uncertainty Analysis applies probability distributions around input variables (based on data, 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 use 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.[12]

For purposes of the DEIS, the terms “elevated” and “exceedance” are used to describe the existing or predicted concentrations of certain parameters in surface or groundwater. “Elevated” indicates that the concentration is/would be above existing baseline concentrations in the Project area, but below groundwater evaluation criteria or surface water standards. An “exceedance,” however, indicates that the concentration is/would be above the applicable criteria or standard.

The potential water quality risks associated with the transportation, storage, and use of hazardous substances are addressed in the Hazardous Materials section of this DEIS (Section 4.12) and were determined to be low.

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 4.1-17). Most process water would be treated at the WWTF, but would not be directly discharged to surface waters. Instead, process water would either be pumped to the Tailings Basin or to the East Pit. Some process water (e.g., runoff from overburden storage and laydown area and from some construction areas) would not be treated at the WWTF because PolyMet expects it to meet surface water standards without treatment. 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 most 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 would then pump the process water via the CPS to the Tailings Basin for reuse at

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[12] 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.

the Plant Site (Figure 4.1-18). This process water represents a reduction in surface water drainage and groundwater flow to the Partridge River. In general, surface seepage from the Tailings Basin would be collected and pumped back to the Tailings Basin, while groundwater seepage from Cell 2E would flow toward the Embarrass River. Make-up water would be withdrawn from Colby Lake. Stormwater (i.e., any water that has not contacted disturbed surfaces) 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 flooding the East Pit, or could continue to be routed to the Tailings Basin, depending on the water level in the East Pit (Figure 4.1-19). 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 4.1-20). Water withdrawals from Colby Lake would only be needed to maintain water levels in the Tailings Basin pond and are expected to be minimal. All Mine Site 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 227 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.[13]

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 from precipitation with Colby Lake withdrawals as a back-up, over a portion of the Tailings Basin for water quality purposes. All collected surface seepage would be pumped back into the Tailings Basin until the seeps dry out or water quality discharge limits are met, except for Second Creek where the seepage recovery system would be removed at Closure. The collected Hydrometallurgical Residue Cell drainage, which previously was being reused at the Plant Site, would be pumped/trucked to the WWTF for treatment until approximately Year 34, when the drainage is expected to end.[14]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[13] It is the tribal cooperating agencies' position that the long-term effectiveness of the wetland treatement system has not been demonstrated by the applicant (see discussion of constructed wetlands below).

[14] 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 begins to overflow and drain to the Partridge River, which is estimated to occur around Year 65 (Figure 4.1-21). The West Pit overflow 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.[15]

The principal hydrologic input to the Tailings Basin would be precipitation, although water could be withdrawn from Colby Lake during droughts if needed to maintain the tailings pond and keep underlying tailings saturated. The volume of seepage from the Tailings Basin is expected to decrease slowly over time, but, with no proposed dry cap, long-term groundwater seepage would be expected.[16] Most surface seeps are expected to dry out within a few years of closure based on experience with the LTVSMC Tailings Basin, although the surface seepage to Second Creek (Seeps 32-33, Figure 4.1-14) is expected to continue indefinitely based on experience after the closure of LTVSMC Cell 1E.

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

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[15] Tribal cooperators note that stockpile leachate is predicted to not meet water quality standards for thousands of years (Table 4.1-45).

[16] 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.

characteristics at the Tailings Basin. Table 4.1-33 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).[17]

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 MnDNR believes that actual hydrogeologic characteristics of the Project site do not fit the model assumptions of homogeneous porous media flow (uniform vertical and horizontal conductivity) 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, which confines the potential for strong hydraulic connectivity between the bedrock and till to localized areas. The relatively high clay content of the glacial material and lack of significant quantities of outwash sand and gravel further reduce the potential for strong hydraulic connectivity between the bedrock and surface water features (Adams and Liljegren 2009).

[17] It is the position of the tribal cooperating agencies that 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.

Table 4.1-33 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			
○ Wetland Deposits	0.3 inches/year		
○ Glacial Deposits	1.5 inches/year		
● Calibration – used traditional trial-and-error methods calibrated to hydraulic head targets measured in wetlands, surficial aquifer, and bedrock using automated MODFLOW calibration methods. Predicted baseflow in the Partridge River at monitoring station SW-004 was 1.49 cfs compared with target baseflow of 1.43 cfs.			
Tailings Basin Local-Scale Model (Attachment A-6, RS13B, Barr 2007)			
● 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 NorthMet tailings during Project operations).			
○ Layer 1	LTVSMC Tailings Basin		
○ Layer 2	Underlying native material		
● Hydraulic Conductivity (Horizontal / Vertical in ft/day)			
○ LTVSMC coarse and fine tailings	5	(RS13B)	
○ LTVSMC Slimes	0.031/0.031	(RS13B)	
○ Native drift	65/6.5	(RS13B)	
○ Bedrock	0.000024/0.000024	(RS13B)	
● 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 Tailings 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 Cell 1E (seeps 32, 33, and Knox Creek headwaters was 470 gpm compared with a measured rate of 554 gpm in May 2002).			

Source: RS22, Barr 2008; RS13B, Barr 2007; Barr 2009, *Flotation Tailings Management Plan*

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.[18]

Mine Site

The Proposed Action 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 and Tailings Basin (Years 12-20). Groundwater inflows to the mine pits for several stages of mine development were predicted using the MODFLOW model (Table 4.1-34). 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 flooding of the East and Central pits.

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[18] It is the tribal cooperating agencies' position that the MODFLOW model does not provide credible data outside the footprint of the mine pits.

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.

Table 4.1-34 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	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 flooding the pits. The East and Central pits would be combined in Year 13 forming one large pit. By Year 20, the combined pit would be completely flooded, coincident with backfilling with waste rock.

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). Based on MODFLOW results and other water balance components, the West Pit would completely flood in approximately 53 years (Year 73) after dewatering ceases (RS52, Barr 2007). The Uncertainty Analysis results estimated the average time to completely flood the West Pit would be about 45 years after mine closure (or Year 65), which is the value used in the remainder of this DEIS.

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.[19]

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 near the 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 2009).[20]

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. The existing information strongly suggests that the probability is very low that extensive hydraulic connectivity exists to allow significant

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[19] 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.

[20] It is the position of the tribal cooperating agencies that, 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.

impacts to wetlands and other surface water features at the Mine Site (Adams and Liljegren 2009; and Adams 2009).[21]

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 tracks.” 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).[22]

Wetland complexes can, however, have a mix of bog-like and fen-like features. There can be localized areas of surficial groundwater inflow that would not create evidence of water tracks on aerial photographs. These situations could occur along the wetland/upland fringe or farther out into the wetland as upwelling areas in fens if there is sufficient head differential between the adjacent upland and the wetland. True bogs do not have this feature. Water in these wetlands can have a bedrock signature coming from water flowing over the saturated surface of the bedrock, entering the wetland, and eventually contributing to the Partridge River streamflow at some downstream location (Adams 2009).

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.[23]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[21] It is the position of the tribal cooperating agencies that, 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).

[22] 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.

[23] 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 flood naturally, as supplemented by the backfill of waste rock and process water from the WWTF, and begin overflowing into the West Pit in approximately Year 21. The West Pit would also begin to flood naturally with groundwater inflows, precipitation, and stormwater runoff at the completion of mining in Year 20. These sources would completely flood 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 4.1-22).

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 on-site 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 localized long-term bedrock groundwater elevation being about 10 to 20 feet lower than existing conditions due to the lowered head boundary at the West Pit lake.

<u>Plant Site</u>

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 Proposed Action 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 4.1-35). 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 4.1-35 Summary of Tailings Basin Seepage (gpm)

	Seepage toward Embarrass River						Seepage toward Second Creek		
Mine Year	NorthMet Cell 1E/2E Seepage	NorthMet Hydromet Leakage	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	1,700	0.5	895	2,596	100	2,496	455	455	0
Year 5	2,360	6.7	895	3,262	100	3,162	410	410	0
Year 10	2,590	7.7	895	3,493	100	3,393	597	597	0
Year 15	2,800	7.8	895	3,703	100	3,603	671	671	0
Year 20	3,000	8.7	895	3,904	100	3,804	737	737	0
Post-Closure	490	0.7	610	1,101	0	1,101	290	0	290

Source: Hinck 2009.

PolyMet proposes a surface seepage collection system that would intercept and collect virtually all surface seepage from the Tailings Basin (Figure 4.1-23). The system includes installation of a number of seep cutoff and collection sumps along the perimeter embankments to intercept and collect surface seepage toward the Embarrass River that may develop from Tailings Basin operations (estimated as an average of approximately 100 gpm). PolyMet would also establish a surface 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.

PolyMet proposes to pump all collected surface seepage toward the Embarrass River back into the Tailings Basin until the seeps dry out or appropriate water quality discharge limits are met, while surface seepage to Second Creek would be collected and pumped back into the Tailings Basin during operations, but the seepage barrier would be removed during Closure and any remaining surface seepage (estimated at approximately 290 gpm) would be released to Second Creek.

PolyMet proposes a geomembrane liner overlying a geosynthetic 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 groundwater seepage) from these cells is predicted to range from 0.5 gpm (Year 1) to 8.7 gpm (Year 20) (Hinck 2009). These liner leakage rates assume that only a single cell is open at a time. This liner leakage is expected to seep to the west of Cell 2W and therefore was not included in the groundwater modeling of the area north of the Tailings Basin. However, this leakage, especially with its relatively high sulfate load, was included in the Embarrass River surface water modeling (see discussion in Embarrass River Water Quality Results later in this section).

In summary, the total unrecovered NorthMet groundwater seepage from the Tailings Basin is expected to range from approximately 1,600 gpm in Year 1 (excluding the 895 gpm of residual LTVSMC seepage from Cell 2W) to approximately 2,900 gpm in Year 20 (again excluding 895 gpm of residual LTVSMC seepage from Cell 2W) (Table 4.1-35).

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, given the objectives of the modeling and based on examination of the limited groundwater monitoring data in the wetlands north and northwest of the Tailings Basin (Figure 3.1-13), 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 groundwater 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 groundwater 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 groundwater seepage 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 2,000 gpm of which would be attributable to the Proposed Action (Hinck 2009). Therefore, under the Proposed Action, a significant increase (>100%) in groundwater upwelling relative to existing conditions would be expected. Some of this groundwater seepage 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 Proposed Action could affect groundwater at the Mine Site by leaching principally metals, metalloids (e.g., antimony and arsenic), and sulfate 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 for treatment.

Overburden

In addition to the waste rock and lean ore, the Proposed Action would also need to stockpile overburden. PolyMet classified the overburden into three types based on its physical and chemical characteristics: saturated overburden, unsaturated overburden, and organic soils (peat) (Kearney and Wenigmann 2009). This classification, however, was based on a preliminary characterization effort. More extensive sampling would be needed to fully characterize the overburden material. Recent testing indicates that some of the saturated overburden contains iron sulfides and produced lower pH water in laboratory tests. Stockpiling of this material would expose it to oxidation and could result in acidic conditions, which promote the release of certain metals, especially cobalt, copper, nickel, and zinc, as well as sulfate (Kearney and Wenigmann 2009). Laboratory analysis of the saturated overburden found that it had a median sulfur concentration of 0.06%, consistent with Category 1 waste rock, but a maximum concentration as high as 0.63%, which would be equivalent to Category 4 waste rock. Overburden pebble chemical analysis reported a median sulfur concentration of 0.11% for Duluth Complex pebbles and 0.14% for Virginia Formation pebbles, with an overall maximum concentration of 2.8% (SRK 2009, *Overburden Pebble Chemical Analysis Draft*). Based on the samples tested, the peat and unsaturated overburden are expected to generate leachates with lower sulfate and dissolved metal concentrations than from the saturated overburden.

PolyMet does not intend to sample the overburden during stripping activities, but rather would distinguish the three types based on field determinations. PolyMet proposes to place all of the saturated overburden in the Category 1 and 2 waste rock stockpile, extend the Category 1 and 2 liner system under the overburden material, and compact the overburden material as it is placed to limit oxidation and infiltration (Kearney and Wenigmann 2009), although the effectiveness of compaction to limit oxidation is uncertain. 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 temporary storage and re-use as construction or reclamation material. The groundwater and surface water quality modeling of the Mine Site that is described below accounts for liner leakage from the overburden portion of the Category 1 and 2 waste rock stockpile and seepage from the Overburden Storage and Laydown Area. The predicted overburden leachate water quality was derived from leachate testing of the material (Barr, *Memorandum: NorthMet Waste Management and Modeling Assumptions for Overburden Materia*l, March 24, 2009). Section 4.1.3.5 discusses potential mitigation measures that address overburden management.

<u>Virginia Formation High Wall</u>

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 flooding 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 to reduce long-term oxidation and solute leaching from the wall rock when flooding reaches the design elevation (RS52, Barr 2007), although successful application of this measure has not been demonstrated. The groundwater quality modeling discussed below assumes these mitigation measures are successfully implemented.[24]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[24] 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.

Process Water

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 3.1-1). The proposed treatment system would include chemical precipitation treatment for the drainage with elevated trace metals and/or low pH (e.g., drainage from the waste rock/lean ore stockpiles) and nanofiltration to concentrate the circumneutral drainage with lower levels of trace metals (e.g., pit dewatering, site operations runoff, Category 1 and 2 stockpile drainage) (RS29T, Barr 2007).

The Proposed Action would generate an annual average maximum of 1,600 gpm (3.6 cfs) of process water during Year 10 (Figure 4.1-18). 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 (6.7 cfs) (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 drainage 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 drainage 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 chemical 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.[25]

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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[25] Tribal cooperating agencies note that the analysis of stockpile leachate collection (Table 4.1-45) 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 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 (Table 4.1-36) reflect a combination of state surface and groundwater standards, although the most restrictive of the two is not always proposed since the facility does not actually discharge directly to either surface or groundwaters (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, monitoring of the WWTF effluent is recommended as a leading indicator of potential groundwater issues at the Tailings Basin (see Section 4.1.3.5 for discussion of recommended monitoring measures).

Table 4.1-36 WWTF Treated Process Water Design Target

Parameter	**Unit**	**Process Water Quality Target**	**Groundwater Evaluation Criteria**	**Surface Water Standard [1]**
General Parameters				
Ammonia (un-ionized)	mg/L	0.04	--	0.04
Chloride	mg/L	230	250	230
Dissolved oxygen	mg/L	>5.0	--	>5.0
Fluoride	mg/L	2.0	2.0	--
Hardness	mg/L	250	--	500
Nitrate	mg/L	10	10	--
pH	s.u.	6.0-9.0	6.5-8.5	6.5-8.5
Sulfate	mg/L	250	250	--
Total Dissolved Solids	mg/L	700	500	700
Metals				
Aluminum	µg/L	125	50-200	125
Antimony	µg/L	31	6.0	31
Arsenic	µg/L	10	10	53
Beryllium	µg/L	4.0	0.08	--
Cadmium	µg/L	4.0	4.0	2.5(2)
Cobalt	µg/L	5.0	--	5.0
Copper	µg/L	30	1,000	9.3(2)
Iron	µg/L	300	300	--
Lead	µg/L	19	15	3.2(2)
Manganese	µg/L	50	50	--
Mercury	ng/L	1.3	2,000	1.3
Nickel	µg/L	100	100	52(2)
Selenium	µg/L	5.0	30	5.0
Thallium	µg/L	0.56	0.6	0.56
Zinc	µg/L	388	2,000	120(2)

Source: Table 4, RS29T, Barr 2007

1 Surface water standards reflect the default standards associated with Class 2B, 3C, 4A, 4B, 5, and 6 waters.

2 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

Evaluation Methodology

The effects of the Proposed Action on groundwater quality at the Mine Site were evaluated using deterministic methods 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 oxidation 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 silicate minerals in the rock; 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 later leached if conditions become more acidic with time. Cobalt and nickel, in particular, become much more mobile as pH starts to decrease.

The portion of meteoric water (i.e., 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 geomembrane liner or covered with soil. The type of cover was selected based on the projected water quality from the waste. 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 release rates (mg/kg/week) for 37 constituents from the five waste rock/lean ore stockpiles were estimated using an empirical approach where results from humidity cells (using the 95th percentile release rates) were scaled to estimate solute release from full-size facilities (Table 4.1-37). Final predictions were limited by mineral solubility limits or observed field values ("concentration caps") to determine the reasonableness of the prediction against theoretical limits and known conditions (RS53/42, 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.

Table 4.1-37 Solute Release Scaling Factors

Scaling Factors	Scaling Assumptions
Temperature	0.3 for Category 1 and 2 rock – reduces oxidation rates measured at ~20°C in lab to average air temperature at Mine Site (~2.4°C). 1.0 for Category 3 and 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 the reactive surface area of waste rock is 20% of the rock crush used in the laboratory tests.
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	Base rates assumed to be constant and long term with adjustment for acidic conditions after Year 5. 95^{th} percentile release rate for each unit, rock type, and waste rock category were weighted by mass to produce a composite rate for the entire stockpile.
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.
Acidification Factor	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) despite the fact that the humidity cell data used (130 weeks of data) already reflected the onset of acidic conditions (see Table 2 in RS82). Acidic weathering rates for Virginia Formation and sedimentary hornfels were used directly for the Category 4 waste rock stockpile.

Source: RS53/42, SRK 2007

It should be noted that the NorthMet 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 used in developing dissolution rates for antimony. Instead, the data from the MnDNR-type apparatus was relied on for use in the deterministic modeling. This was the only parameter for which the data from the MnDNR-type apparatus was used. It was recently determined that the antimony dissolution rates from the humidity cell data, instead of the MnDNR-type apparatus, were inadvertently used in the deterministic modeling, but only 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.

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 footprint (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 vegetated soil and geomembrane covers. PolyMet assumed three liner yield scenarios (low, average, and high) based on data from pilot and operational scale 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) and were limited by concentration caps. Under the assumed uniform solute production throughout the rock, seepage concentrations increase in proportion to the height of the stockpile if concentration caps are not reached (for a given stockpile footprint area). All modeling was performed assuming a constant mass release from the rock. The total mass was added to the volume of water moving through the stockpile. Therefore when the volume of water moving through the stockpile was the lowest, the highest solute concentrations were predicted. Assumptions were also made in order to calculate the amount of liner leakage (low, average, and high). These were then used to predict changes in groundwater and surface water quality around the Mine Site.

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 4.1-24). 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). Naturally occurring fractures might also occur, especially in the Virginia Formation. Such fractures tend to dry during pit dewatering, with a resultant oxidation of sulfides present. As the pit and the fractures flood after mining, the products of sulfide oxidation are released to solution.

After inundation, wall-rock oxidation is reduced to a very slow rate 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 is not a substantial source of contaminants to the pit water. 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. As discussed previously, at Closure, PolyMet proposes to place overburden and a low permeability cover over the exposed Virginia Formation walls above the East Pit, 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 high walls that remain above the water levels, input loads from surface drainage and groundwater seepage from waste rock stockpiles, and the load lost in outflow.

Waste rock backfilled to the East Pit would have a chemical effect similar to wall rock, with waste rock above the water surface oxidizing and leaching solutes to the pit lake. When inundated by the pit lake, however, material previously oxidized is released to the water but future leaching is significantly reduced and the submerged rock acts like 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 4.1-38 provides model assumptions and input data.

Table 4.1-38 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	RS52
Tailings seepage and process pond	RS54/46
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 and RS74A
Physical water inflows	RS22, RS10A
Correction 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 – assumed fraction of reactive surface area relative to the rock crush used in the laboratory tests
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 RS53/42)
Solute Release Rates	A constant rate was assumed until the onset of acidic conditions, at which time the rate jumped to a peak and then began an exponential decay based on MnDNR's long term kinetic reactor data (see Appendix B of RS53/42).
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 RS31).
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 – in groundwater at the PolyMet property boundary and in groundwater immediately upgradient from the Partridge River (Table 4.1-39; Figure 4.1-25).[26]

Table 4.1-39 Solute Transport Flow Paths and Evaluation Points

Flow Path	Solute Sources	Groundwater Evaluation Points[1]
#1	Category 1 and 2 and overburden stockpile	Property boundary
#2	West Pit	Property boundary
#3	Lean Ore Surge Pile	Partridge River
#4	East Pit and Category 4 stockpile	Property boundary, Partridge River
#5	Category 3 lean ore stockpile	Partridge River
#6	Category 3 waste rock stockpile	Partridge River

Source: RS74A, Barr 2008.
[1] The groundwater evaluation points reflect groundwater quality directly upgradient from these locations and does not include any water at the surface, which would be subject to surface water quality standards.

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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[26] 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. Corresponding information for that evaluation point must be included in Table 4.1-39.

Key model assumptions and input variables are provided in Table 4.1-40. 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 Year 65, groundwater outflow from the West Pit toward the Partridge River would begin, again at a low rate (i.e., 18 gpm).

Table 4.1-40 Screening and Transient Solute Transport Model Inputs and Assumptions - Mine Site

Evaluation Points	Property boundary and the Partridge River (Figure 4.1-25)			
Evaluation Criteria	Primary and secondary USEPA drinking water standards and Minnesota Health Risk Limits (Table 4.1-4)			
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 1 and 2 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 lean ore stockpile	12.2	0.61
	6	Category 3 waste rock stockpile	12.5	0.625
Source Flow Inputs	Hydrologic head distribution at Closure as predicted by Mine Site MODFLOW model			
	Maximum predicted leakage rates for the waste rock stockpiles (only for Steady State Model)			
	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			
Baseline 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 and was only applied if there might be a water quality parameter that exceeded groundwater evaluation criteria; 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 amount 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. These two assumptions are discussed below.

Liner Leakage

The amount of liner leakage from the waste rock and lean ore stockpiles is primarily determined by the type of liner, overliner slope, the quality of liner installation as measured by installation defects (i.e., number of holes or tears in the liner), and subgrade permeability. In order to minimize leakage, PolyMet proposes a minimum of a 1% overliner slope and a maximum of two installation defects per acre. Subgrade permeabilities would vary based on the type of waste stockpiled - 1 x 10^{-5} cm/sec for the Category 3 waste rock stockpile and 1 x 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 evaluated involving low, average, and high liner leakage rates to estimate potential groundwater quality impacts. The PolyMet proposed design, if achieved, would result in leakage that varies by stockpile from less than the low liner leakage scenario to approximately the average liner leakage scenario (Table 4.1-41).

The proposed liner system should be able to be installed in accordance with the proposed design if rigorous quality control measures are used in accordance with industry standards. 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, concerns remain regarding the ability of this liner system to permanently maintain these design criteria (e.g., if liner foundations are not adequately prepared then differential settlement could cause tears in the geomembrane liner), the potential for the geomembrane liner to degrade over long periods of time, and the adequacy of the proposed overliner buffer 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. These concerns suggest that use of the low and average liner leakage rates for purposes of groundwater quality modeling could underestimate the rate of liner leakage and result in underestimates of the solute loadings to groundwater. Section 4.1.3.5 discusses potential mitigation measures that address these concerns.

On the other hand, the high liner leakage rate assumes a combined worst case scenario of overliner slope flatter than specified, a greater number of defects per acre, and subgrade permeability greater than specified, which is unlikely and would result in unreasonably high estimates of liner leakage. Since modeling was only conducted for these three scenarios, however, the high liner leakage rate (at least where this rate results in the highest predicted solute concentrations) is relied on in evaluating model results in order to be protective of the environment, but recognizes that use of this leakage value may overestimate groundwater quality impacts.

Table 4.1-41 Comparison of Liner Leakage Estimates under the Deterministic Modeling and Actual Proposed Design

Stockpile	Liner Leakage Case	Overliner Slope (ft/ft)	Subgrade Permeability (cm/s)	Installation Defects (holes/acre)	Liner Yield Operations (inches/year)	Liner Leakage Operations (gallons/acre/day)	Liner Yield Post-closure[1] (inches/year)	Liner Leakage Post-closure[1] (gallons/acre/day)
Category 1 and 2 and overburden	Det. Low	0.5	5×10^{-7}	NA[2]	8.2	377	4.7	297
	Det. Average	0.5	5×10^{-7}	NA[2]	14.2	426	10.2	408
	Det. High	0.2	5×10^{-6}	NA[2]	20.4	1,496	14.7	1,088[(6)]
	Actual Design[3]	0.5	5×10^{-7}	NA[2]	14.2[(4)]	426	10.2	408
Category 3 waste rock	Det. Low	1.0	1×10^{-5}	4	8.2	0.30	3.4	0.13
	Det. Average	1.0	1×10^{-5}	4	14.2	0.49	7.4	0.26
	Det. High	0.5	1×10^{-5}	8	20.4	2.54	10.9	1.41
	Actual Design[3]	1.0	1×10^{-5}	2	14.2[(4)]	0.24	7.4	0.13
Category 3 lean ore	Det. Low	1.0	1×10^{-6}	4	8.2	0.06	3.5	0.03
	Det. Average	1.0	1×10^{-6}	4	14.2	0.09	7.6	0.05
	Det. High	0.5	1×10^{-5}	8	20.4	2.54	11.2	1.46
	Actual Design[3]	2.0	1×10^{-6}	2	14.2[(4)]	0.02	7.6	0.013
Category 4 waste rock	Det. Low	1.0	1×10^{-6}	4	8.2	0.06	0.1	0.003
	Det. Average	1.0	1×10^{-6}	4	14.2	0.09	0.3	0.003
	Det. High	0.5	1×10^{-5}	8	20.4	2.54	1.5	0.24
	Actual Design[3]	2.0	1×10^{-6}	2	14.2[(4)]	0.02	0.3	0.0001
Lean ore surge pile	Det. Low	1.0	1×10^{-6}	4	8.2	0.06	NA	NA[(5)]
	Det. Average	1.0	1×10^{-6}	4	14.2	0.09	NA	NA[(5)]
	Det. High	0.5	1×10^{-5}	8	20.4	2.54	NA	NA[(5)]
	Actual Design[3]	2.0	1×10^{-6}	2	14.2[(4)]	0.02	NA	NA[(5)]

Source: Tables 4-3, 4-5, and 4-6, RS74A, Barr 2008; Table 2, Wong et al. 2009.

1 Assumes 100% reclaimed stockpile and reflects area weighted liner yield for both evapotranspiration and geomembrane caps, as applicable.

2 PolyMet does not propose a composite liner for the Category 1 and 2 and overburden stockpile so composite liner installation defects is not applicable for this stockpile.

3 Actual design reflects PolyMet's proposal.

4 Liner yield is not a design criterion per se. Average liner yield was assumed for purposes of estimating liner leakage for the actual design case.

5 The Lean Ore Surge Pile is a temporary stockpile and would be removed during closure.

6 The high liner leakage rate for the Category 1 and 2 overburden stockpile exceeds the transmissivity of the underlying aquifer. In this case, groundwater could start to mound in the stockpile, but would be collected by the liner drainage system and pumped to the WWTF.

Sorption

Many contaminants, including metals, are known to adsorb (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 are differences in the degree of confidence that USEPA has in these data based on the number and variability of K_d values in the scientific literature (Allison and Allison 2005). Table 4.1-42 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 4.1-42 USEPA Guidance Regarding Sorption Values (K_d in L/kg)

Metals	K_d Median	K_d Range	USEPA K_d Estimated Screening Level Values[1]	Confidence Level 1=highest, 4=lowest[2]
Antimony	251	1.3 – 501	45	4
Arsenic	2,512	2 – 19,953	25 – 31	2
Copper	501	1.3 – 3,981	Not Available[3]	1
Nickel	1,259	10 – 6,310	16 – 1,900	1

1 USEPA 1996.
2 Allison and Allison 2005
3 USEPA did not develop an estimated screening level value for copper

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 4.1-43). 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 to accept the low end of the USEPA screening levels, except for antimony. Although some degree of sorption would be expected to occur for antimony, the results of the site-specific testing and our concerns regarding the protocol used for the sampling lead to an assumed K_d value of zero at this time. Table 4.1-43 presents the results of the site specific sorption testing and the values accepted for use in evaluating the results of the groundwater modeling at the Mine Site.

Table 4.1-43 Comparison of Site Specific and Literature Sorption Values[1] 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.
1 All values in L/kg.

Although not included in the sorption testing, both iron and manganese do sorb, although their concentrations are primarily controlled by local equilibrium processes within the aquifers so sorption models alone are not likely to accurately characterize concentrations of these elements.

<u>Deterministic Model Results</u>

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 by conservatively combining the highest liner leakage rate (typically Year 20) with the highest solute concentrations. Table 4.1-44 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 baseline 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.

Those solutes that were identified as potentially exceeding groundwater evaluation criteria (Table 4.1-44) using the initial steady state modeling, as well as sulfate, were then subjected to more detailed analysis using transient flow modeling. Table 4.1-45 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, use of the lower range of the USEPA screening level sorption values for arsenic, copper, and nickel is accepted based on the results of the site-specific sorption testing. Similarly, those solutes that are predicted only to exceed groundwater evaluation criteria under the conservative high liner leakage conditions are evaluated on a case by case basis. 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.

Table 4.1-44 Summary of Potential Groundwater Evaluation Criteria Exceedances at the Mine Site Using Steady State Model

Flow Path	Potential Groundwater Evaluation Criteria Exceedances	Additional Constituents for Transient Model
#1 - Category 1 and 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,** *aluminum, beryllium, thallium*	Sulfate
#4 - East Pit and Category 4 waste rock stockpile	**Antimony, iron, manganese, nickel.** *aluminum, beryllium, thallium*	Sulfate
#5 - Category 3 lean ore stockpile	**Copper**, **iron**, **manganese**, **nickel,** *aluminum, beryllium, thallium*	Sulfate
#6 - Category 3 waste rock stockpile	**Antimony, arsenic, copper, iron, manganese, nickel, sulfate**, *aluminum, beryllium, thallium,*	--

Source: Modified from Table 6-24 in RS74A, Barr 2008.

Notes: Constituents in **bold** or *italics* are predicted to potentially exceed groundwater evaluation criteria and are carried forward for transient flow modeling. Constituents in *italics* were not carried forward to transient modeling because the predicted exceedance is attributable to high baseline concentrations.

As Table 4.1-45 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), nickel (at two flow paths) and sulfate (at two flow paths) are predicted to exceed groundwater evaluation criteria. 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, or the concentration cap issued discussed previously.

Table 4.1-45 Summary of Maximum Concentrations Predicted Using Deterministic Transient Flow Modeling for the Mine Site under the Proposed Action

Parameters	Units	Groundwater Evaluation Location[1]	Groundwater Evaluation Criteria	Liner Leakage Model(s) with Criteria Exceeded7	Predicted Maximum Concentration[2]	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, Average, High*	**$16^{(5)}$**	~100 – 2000	**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	**$12.3^{(4)(5)}$**	~550 - 2000	**$12.3^{(4)}$**
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*	$470^{(3)(6)}$	None	470
Manganese	μg/L	Partridge River	300	*High*	$66^{(3)(6)}$	None	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*	**$15^{(5)}$**	~90 – 250	**15**
Iron	μg/L	Partridge River	300	Low, Average, *High*	$500^{(5)}$	None	500
Manganese	μg/L	Partridge River	300	None	110	None	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 Lean Ore Stockpile							
Copper	μg/L	Partridge River	1,000	None	43	None	920
Iron	μg/L	Partridge River	300	*High*	$1,300^{(3)(6)}$	None	1,300
Manganese	μg/L	Partridge River	300	None	$250^{(3)}$	None	250
Nickel	μg/L	Partridge River	100	*High*	**$650^{(3)}$**	~50 – 2000	**3,400**
Sulfate	mg/L	Partridge River	250	None	58	None	58
Flow Path #6 - Category 3 Waste Rock Stockpile							
Antimony	μg/L	Partridge River	6	*Low*, Average, High	**$41^{(5)}$**	~100 – 2000	**41**
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*	$4,200^{(6)}$	None	4,200
Manganese	μg/L	Partridge River	300	Low, Average, *High*	**900**	~50 – 2000	**900**
Nickel	μg/L	Partridge River	100	Average, *High*	**1,000**	~50 – 2000	**12,000**
Sulfate	mg/L	Partridge River	250	*High*	**$280^{(3)}$**	~100 – 200	**280**

Source: Modified from Table 6-30, 6-31, and 6-32, RS74A, Barr 2008.

Notes: Values in **bold** exceed groundwater evaluation criteria.

1 The Partridge River Groundwater evaluation point reflects groundwater directly upgradient from the Partridge River and does not include water flowing in the river, which would be subject to surface water quality standards.

2 Predicted concentrations assume sorption of arsenic, copper, and nickel using the K_d values presented in Table 4.1-43.

3 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.

4 Predicted antimony concentration was revised subsequent to the issuance of RS74A because the dissolution rate originally used was based on the NorthMet humidity cells, which were contaminated for antimony, rather than the MnDNR reactor data. See Hinck, Pint, and Wong; *Revised Model Results for Antimony at the Mine Site*, September 25, 2009.

5 The predicted antimony concentrations rely on the concentration cap developed from the contaminated humidity cell testing (80 μg/L) rather than MnDNR reactor data (3 μg/L), which probably results in overestimates of antimony concentrations in groundwater at the Mine Site.

6 As discussed in Section 4.1.2.2, elevated iron (above the secondary MCL of 300 μg/L) and manganese (above the secondary MCL of 50, but below the HRL of 300 μg/L) are not considered exceedances of the groundwater evaluation criteria in this DEIS because the high baseline concentrations in groundwater.

7 Liner leakage scenarios in italics result in predicted maximum concentrations.

Waste Rock Stockpiles Uncertainty Analysis

The Proposed Action would involve the permanent storage of the most 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 concentration 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 to groundwater through 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 and 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 the Category 1 and 2 waste rock stockpile, and years 15 and 25 for the Category 3 lean ore stockpile.

The deterministic modeling and the Uncertainty Analysis used different input assumptions (Table 4.1-46). The net effect of these differences can be assessed by comparing the final solute loadings in the liner yield (water reaching the liner) for the common parameters used in each model. As Table 4.1-47 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 4.1-46 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, which reflect the onset of acidic conditions, and still applied an acidification factor of about 10 to account for additional acidity.	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 about 10 to account for anticipated increased acidity.
Composite Scaling factors	0.1	Assumed distribution with median of 0.075 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, except 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 and 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 (e.g., 2x on average) were used to increase concentration caps to capture uncertainty.
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, 50^{th,}, 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.	Determined liner leakage factor distribution based on uncertainty in liner slope, liner defects, and subgrade permeability parameters. Different distributions used for Category 1 and 2 waste rock and Category 3 lean ore (see Figures 6 and 7, Hinck and Wong 2008).
Sorption	Models run with and without sorption	No sorption considered

Source: Hinck and Day 2009; Hinck and Wong 2008.

Table 4.1-47 Comparison of Final Solute Liner Yield 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[1]**	**(mg/kg/week)**	**Liner Yield Probability**	**(mg/kg/week)**
Antimony	High	**0.000015**	95th	0.0000011
	Average	**0.000010**	Mean	0.0000007
Arsenic	High	0.00013	95th	**0.0003**
	Average	0.00009	Mean	**0.0002**
Cobalt	High	**0.0081**	95th	0.0033
	Average	**0.0056**	Mean	0.0007
Copper	High	**0.037**	95th	0.0048
	Average	**0.026**	Mean	0.0016
Fluoride	High	0.000011	95th	**0.00029**
	Average	0.000008	Mean	**0.00019**
Nickel	High	**0.12**	95th	0.0375
	Average	**0.10**	Mean	0.0088
Sulfate	High	1.8	95th	**3.3**
	Average	1.2	Mean	**2.1**
Vanadium	High	**0.00046**	95th	0.00007
	Average	**0.00046**	Mean	0.00005

Source: Tables 1a and 1b, Hinck and Day 2009.
Note: Higher values shown in **bold**.
[1] Table 4.1-41 for estimates of high and average liner yield for the deterministic modeling.

The results of the Uncertainty Analysis for the rock stockpiles (i.e., only Category 3 lean ore and Category 1 and 2 waste rock 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 #5), none of the 5,000 model runs yielded liner leakage loading rates 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 #6), the Uncertainty Analysis would suggest that the deterministic model results for these stockpiles may be conservatively high.

Similarly, the simulations of the Category 1 and 2 and overburden stockpile (i.e., solute source for Flow Path #1) indicated that the deterministic 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 deterministic model may have under-estimated 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 (CaF2) saturation. As indicated in Table 4.1-46, the Uncertainty Analysis did not consider the effects of CaF2 precipitation, without which the results may yield unrealistically high estimates of fluoride concentrations. High cobalt and copper concentrations in the Uncertainty Analysis are the result of the using a range of pH from 6.6 to 8.0 for determining the concentration caps in the simulation. Over this range of pH, the maximum concentration for each of these metals is very sensitive to changes in pH, resulting in the difference between the Uncertainty Analysis and the deterministic model results. The Uncertainty Analysis did not consider the effects of sorption on arsenic, copper, or nickel as was done in the deterministic modeling. In terms of copper, consideration of sorption is expected to result in predicted copper concentrations from the Category 1 and 2 and overburden stockpile remaining below the groundwater evaluation criteria.

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 flow via East Pit treatment wetlands;
- East Pit subsurface flow;
- Surface runoff to East Pit;
- Surface runoff to West Pit;
- Groundwater inflow to East Pit;
- Groundwater inflow to West Pit;

- Category 1 and 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 at 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 could possibly 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 could possibly 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), applying 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 excluding of the effects of adsorption in the West Pit water (applies to copper). Nevertheless, based on the results of the Uncertainty Analysis, there is the potential that nickel and sulfate may exceed groundwater evaluation criteria at the Property Boundary. Groundwater outflow from the West Pit would be approximately 18 gpm.

<u>Conclusions</u>

Within the 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 immediately upgradient of Partridge River).

In some cases the results of the deterministic modeling and the Uncertainty Analysis conflict, which makes it difficult to draw firm conclusions (Table 4.1-48). Nickel, for example, is predicted by the deterministic modeling to meet groundwater evaluation criteria in the West Pit. The Uncertainty Analysis, on the other hand, suggests that the deterministic modeling predictions underestimated nickel concentrations in the West Pit. 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 groundwater evaluation criteria for at least several solutes (i.e., antimony, manganese, nickel, and sulfate along several flow paths), even when accounting for high liner leakage rates and assuming natural attenuation by sorption. As indicated in Table 4.1-45, some of the waste rock stockpiles have the potential to leach solutes to groundwater for long periods (i.e., over 2,000 years), so these effects would be significant (RS74A, Barr 2008).

Table 4.1-48 Summary of Deterministic Groundwater Modeling and Uncertainty Analysis at the Mine Site

Flow Path	Source	Groundwater Evaluation Point	Results of Deterministic and Uncertainty Analysis
1	Category 1 and 2 & overburden	Property Boundary	Antimony[2] may exceed groundwater evaluation criteria.[4]
2	West Pit	Property Boundary	Antimony, nickel, and sulfate may exceed groundwater evaluation criteria.[3]
3	Lean Ore Surge Pile	Partridge River[1]	All parameters are predicted to comply with groundwater evaluation criteria.
4	East Pit & Cat 4 Waste Rock	Partridge River[1]	Antimony may exceed groundwater evaluation criteria.[2]
5	Category 3 lean ore stockpile	Partridge River[1]	Nickel may exceed groundwater evaluation criteria.[4]
6	Category 3 waste rock stockpile	Partridge River[1]	Antimony, manganese, nickel, and sulfate may exceed groundwater evaluation criteria.

Sources: RS74A, Barr 2008; Hinck and Wong 2008.

1 The Partridge River Groundwater Evaluation Point reflects groundwater quality directly upgradient from the Partridge River and does not include water flowing in the river, which is subject to surface water quality standards.

2 Antimony may not exceed groundwater evaluation criteria at this Flow Path when use of the concentration cap from the contaminated humidity cells and sorption are considered.

3 Nickel and sulfate are only predicted to exceed the groundwater evaluation criteria at this Flow Path under the Uncertainty Analysis, not the deterministic model.

4 These parameters are only predicted to exceed the groundwater evaluation criteria at this Flow Path under the deterministic model, not the Uncertainty Analysis.

There are several key assumptions in the deterministic modeling and Uncertainty Analysis for the Mine Site that warrant further evaluation, including:

- The predicted dissolution rates used as input to the deterministic modeling and the Uncertainty Analysis were based on results from 130 and 60 week humidity cell data, respectively (Table 4.1-46). Humidity cell testing is continuing and changes in dissolution rates that may occur over time could affect the accuracy of the groundwater quality predictions.

- Concentration caps were used to limit concentrations of certain parameters as inputs to the deterministic modeling and the Uncertainty Analysis in the Mine Site water quality modeling (Table 4.1-46). These caps were primarily derived from NorthMet humidity cell laboratory results and some were based on AMAX test pile results. Empirically determined caps, especially from laboratory tests, may not be conservative as the amount of mineral surface area contacted by water passing through the full height of a waste rock stockpile is much greater than the surface area contacted by water passing through a humidity cell.

- An acidification factor of approximately 10 was used to account for the effect of an anticipated pH decrease on stockpile dissolution rates in both the deterministic modeling and the Uncertainty Analysis (Table 4.1-46). Data from the AMAX test piles suggest that this acidification factor is very low for copper and nickel (Lapakko, *Comments on Uncertainty Analysis Workplan Tab 3b Monte Carlo Simulation – Waste Rock Memo*, September 16, 2008). Clarification is required regarding the methods and data used by PolyMet in determining the acidification factor.

Effects on Groundwater Along the Transportation Corridor

The transportation corridor between the Mine and Plant sites includes the Dunka Road, the rail line, and the process water pipeline. No significant effects on groundwater are expected from the construction or use of the Dunka Road or the process water pipeline. Operation of the rail line, however, creates the potential for the spillage of ore fines or rock through gaps in the rail cars. Such spillage could expose groundwater along the rail line to contamination by reactive ore. In comparison with the total volume of waste rock and ore, the amount spilled from the rail cars is expected to be very small. Nevertheless, PolyMet proposes to minimize this risk by placing fines in the center of the rail cars during loading to minimize spillage. Monitoring is recommended to determine the effectiveness of this proposed mitigation measure. Other potential mitigation measures are identified in Section 4.1.3.5 if the proposed measure proves inadequate.

Effects on Groundwater Quality at the Tailings Basin

Most seepage from the Tailings Basin would flow northward towards the Embarrass River and 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.

These solutes can be released from tailings by direct dissolution of minerals, but solutes of concern are released primarily 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, typically with slower oxidation in wetter material. Thus the unsaturated tailings in the embankment and beach areas are expected to have higher oxidation rates than the saturated tailings below the pond, which would be essentially non-reactive.

Solutes released by oxidation (primarily sulfate and metals) would be flushed from the tailings by percolating water. The rate of percolation would depend on the surface properties 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.

The pilot plant testwork shows that sulfur concentrations in the produced tailings can be expected to vary in response to changes in process conditions, especially the use of copper sulfate, which improves the recovery of sulfide minerals during flotation. Pilot testing using the final Processing Plant design and including the addition of copper sulfate resulted in average sulfur concentrations in the tailings of 0.12% (range of 0.10 to 0.13%; 0.13% was used in the water quality modeling) (SRK, *PolyMet Mitigation Modeling Assumptions*, June 23, 2009). The critical sulfur content of the tailings (i.e., the sulfur content at which acid drainage could be produced) is estimated between 0.14 to 0.17% sulfur. This is slightly above the range of sulfur values produced in the tailings by pilot plant tests when copper sulfate was used. Pore water metal concentrations can increase dramatically if pH decreases, especially for nickel and cobalt (RS54/46, SRK 2007). The oxyanions (arsenic, antimony, and selenium), however, tend to have increasing solubility with higher pHs.

Testing of tailings containing 0.2% sulfur by MnDNR and from the nearby Babbitt Deposit did not result in acidic leachate because silicate weathering was able to neutralize the acid produced. 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 pH showed an initial decline in pH, but has subsequently remained between 6.0 and 7.8 with no trend toward lower pHs. Variation in pH is a function of residual sulfur content and 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 NorthMet tailings would pass through the underlying LTVSMC tailings (i.e., previous taconite tailings). These underlying tailings may attenuate metals or acidity leached from the NorthMet tailings, and/or may contribute additional solutes to seepage. In order to better understand this dynamic, PolyMet conducted humidity column testing of the interaction between NorthMet leachate and LTVSMC tailings. Based on kinetic testing, 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).

NorthMet 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 LTVSMC coarse tailings. NorthMet tailings would not be used as embankment material.

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 deposit the NorthMet tailings by conventional spigotting and by diffuser in subaqueous zones to minimize oxidation and associated release of solutes (Figure 3.1-28). Nearly all surface seepage would be collected via horizontal drains, seepage collection trenches, and sump/pump systems and returned to the Tailings Basin. After operations cease in Year 20, PolyMet proposes to cap the NorthMet tailings beach adjacent to the exterior embankment with a bentonite amendment to limit water infiltration and reduce oxidation of the tailings. By covering the tailings beaches, seepage from the Tailings Basin would depend largely on the permeability of the finest tailings under the pond. Once mining operations cease, PolyMet would also inject the tailings below the pond with bentonite using pre-manufactured agricultural equipment mounted on a pontoon. The surface seepage collection system would continue to operate into Closure until the seeps effectively dry out or the seepage meets appropriate surface water quality discharge limits.

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 4.1-35 (Hinck 2009).

Evaluation Methodology

A series of spreadsheet models were used to predict the concentration of dissolved constituents in the seepage from the Tailings Basin that bypasses the collection system and is released to the environment (RS54/46, SRK 2007; RS74B; Barr 2008). These models provided predictions of pond chemistry and pollutant loads from dissolution of NorthMet tailings and the taconite tailings used for embankment construction. The transport times for water from these source areas to reach the base of the Tailings Basin were predicted using the groundwater flow and transport model MODFLOW-SURFACT. This model includes the ability to simulate unsaturated flow, which is why it was chosen for this application. A spreadsheet model then used the predicted flow, mass load, and transport times (assuming plug flow) for each source area within the Tailings Basin (i.e., embankments constructed out of LTVSMC tailings and beach and pond area containing NorthMet tailings). Table 4.1-49 provides a summary of the assumptions and inputs used in the model.

Table 4.1-49 Tailings Basin Water Quality Model Assumptions and Inputs

Model Inputs	Source of Input Data	Reference
Source Areas Evaluated	Assumed embankments constructed of LTVSMC tailings. Assumed beach and pond areas consisted of NorthMet bulk tailings (both capped and uncapped).	RS74B - Figures 8-1 thru 8-4
Source Term Flows	Infiltration into and flows from Embankment, Beach, and Pond areas. Infiltration for each year of operation and Closure.	RS74B - Table 8-1
Solute mass loadings	Provided for each year of operations and Closure for each source area.	RS74B – Tables 8-2 thru 8-5
Release ratios	Values for maximum rate of sulfide mineral oxidation and associated metal release in oxygenated tailings were based on average humidity cell test results.	Attachment 1 to Barr 2009, Tailings Basin Seepage Quality Predictions
Travel Time	Considered only advection and resulted in breakthrough curves	RS74B – Figures 8-5 thru 8-15
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.	Attachment 1 to Barr 2009, Tailings Basin Seepage Quality Predictions
Tailings Oxygen Diffusivity	Oxygen diffusivity in tailings (i.e., the ability of the tailings to transmit oxygen gas, a function of porosity and moisture content	Attachment 1 to Barr 2009, Tailings Basin Seepage Quality Predictions
Effluent Solute Concentrations	Concentrations of solutes in Tailings Basin effluent was calculated by combining water and mass loads from various sources - embankment, beach, pond - as determined from the Tailings Basin construction plan.	
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 is frozen 25% of the time; however, lower diffusion in frozen ground surface was not supported by MnDNR's literature review.	
Vertical saturated conductivity	5.4×10^{-5} cm/s in NorthMet bulk tailings	Attachment 1 to Barr 2009, Tailings Basin Seepage Quality Predictions
Porosity	0.5 in bulk tailings	RS39/40 Appendix H
Infiltration Rate Thru Tailings	15-26 in/yr for active beach areas during operations (i.e., when spigotting water onto tailings)	Attachment 1 to Barr 2009, Tailings Basin Seepage Quality Predictions, RS13B
	8 in/yr for embankments and inactive beach areas	
	3.58 in/year for bentonite amended tailings areas in Closure	
Water Saturation	58% in bulk NorthMet tailings, 35% in LTV embankments	Attachment 1 to Barr 2009, Tailings Basin Seepage Quality Predictions
	~100% in tailings slime (below pond), which reduces oxidation rate to essentially 0	

Table 4.1-50 provides the predicted seepage water quality as it leaves the Tailings Basin, not accounting for any dispersion, 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 evaluation criteria.

Table 4.1-50 Water Chemistry of Cells 1E and 2E Seepage to Groundwater

	Unit	Years 1-6[(1)]	Year 10	Year 15	Year 20	Closure	Maximum Conc.[(2)]
General Parameters							
Calcium	mg/L	73	104	76	60	68	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	113	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	µg /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: Table 1, Pint 2009, *Technical Memorandum: Tailings Basin Seepage Quality Predictions*, June 24, 2009.

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.

2 Table 4.1-50 only presents predicted water chemistry for 5 year increments. Maximum concentration reflects highest predicted concentration for any of the 20 years of operations or Closure.

A two-step modeling approach was used for evaluating Project effects on groundwater quality, including both steady state and transient flow modeling (Table 4.1-51), both of which use the predicted seepage water quality at the toe of the Tailings Basin (Table 4.1-50) 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 groundwater 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. 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 4.1-51 Steady State and Transient Flow Model Inputs and Assumptions

Evaluation Points	Groundwater immediately upgradient of the 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 (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)	D_x(m)
	63	19.2
Source Term Flows	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 0.3 inches per year based on a calibration of the transport model to observed chloride concentrations. Recharge is only applied where the simulated water level is below a specified water elevation. Generally, the model predicted that the initial 1,400 feet (450 meters) north from the toe of the Tailings Basin was a groundwater discharge area, while the area further from the Tailings Basin was a recharge area.	
Source Term 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.	
Baseline 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 – 52 meters; Δy – 10 meters; Δz – surficial deposits – 1 meter The model consists of 1 layer of variable thickness.	
Hydraulic Conductivity	Values based on average value determined as part of the Tailings Basin hydrogeologic investigation Kx – Surficial deposits 13 ft/day (4 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.*

The groundwater transport model was used to predict groundwater concentrations at three evaluation points along a flow path north from the basin (Figure 4.1-26):

- 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
- Directly upgradient from the Embarrass River (approximately 15,500 feet from the toe of the Tailings Basin embankment).

<u>Steady State Flow Model Results</u>

The steady state flow model predicted the quality of groundwater downgradient of the Tailings Basin using the maximum predicted Tailings Basin groundwater 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; the simulation included only advection and dispersion. 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 simulation, 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 4.1-52). As discussed in the evaluation of the waste rock stockpile seepage, the site specific sorption results are compelling enough to accept the low end of the USEPA screening level values, except for antimony. Although sorption is a well accepted physical and chemical process, there are a finite number of sorption removal sites. Water quality monitoring should be required to ensure that actual groundwater concentrations are within model predictions (see Section 4.1.3.5 for a discussion of recommended mitigation and monitoring measures).

Table 4.1-52 Comparison of Site Specific and Literature Sorption Values at the Tailings Basin

	Literature Sorption Value	**Site Specific Sorption Values**			
Parameter	**USEPA Screening Value**	**Boring GW-009**	**Boring RS- 21**	**Average**	**K_d Values Accepted for Use in Groundwater Modeling**
Antimony	45	15.4	5.5	10.4	2
Arsenic	25	297	105	201	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.*

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, using either the USEPA screening level value or the average site specific K_d value is not acceptable. 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 for the Proposed Action.

Table 4.1-53 provides a summary of the transient flow modeling results, which shows that only aluminum (at two evaluation points) is predicted to exceed the minimum range of the groundwater evaluation criteria, but would remain below the upper range of the 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. The predicted levels of aluminum would be within the range of ambient groundwater concentrations found in nearby wells (Table 4.1-8).

Table 4.1-53 Summary of Maximum Concentrations Predicted Using Transient Flow Modeling at the Tailings Basin

Solute	**Unit**	**Groundwater Evaluation Criteria**	**Predicted Maximum Concentration**			**Period Exceeding Groundwater Criteria (Mine Years)**	**Predicted Maximum Concentration (no sorption) Prop boundary**
			Property Boundary Point	**Residential Well Evaluation Point**	**Embarrass River Evaluation Point[2]**		
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[(1)]	3.0[(1)]	3.0[(1)]	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	300	192	193	193	NA	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: Values in **bold** exceed groundwater evaluation criteria.
1 Predicted arsenic concentrations were modeled assuming a K_d value of 25, Table 4.1-43
2 The Embarrass River Groundwater Evaluation Point reflects groundwater quality directly upgradient from the Embarrass River and does not include water flowing in the river, which is subject to surface water quality standards (Figure 4.1-26).

Sulfate concentrations are predicted to remain below the groundwater evaluation criterion (250 mg/L) at all evaluation locations. The effects of this predicted sulfate loading on surface water quality in the Embarrass River 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 Proposed Action would have relatively little adverse effect on groundwater quality downgradient of the Tailings Basin. Predicted aluminum concentrations would be within the range of natural baseline concentrations for the area, within the range of concentrations found at nearby residential wells, below the upper end of the USEPA secondary MCL range, and would not pose a risk to human health.[27]

There are several key assumptions in the deterministic modeling for the Tailings Basin that warrant further evaluation, possibly using Uncertainty Analysis, including:

- Current modeling assumes no segregation of tailings as they would be spigotted into the Tailings Basin (i.e., bulk tailings). In fact, partial segregation would occur as coarser tailings segregate from the finer tailings. The extent of tailings segregation is important in that the poorest water quality comes from the oxidation of coarse tailings. The grain size for the NorthMet tailings is finer and more uniform than taconite tailings, but segregation would likely still occur.

- The current geochemical modeling assumes a beach width of 625 feet around the Tailings Basin. This width is the minimum required for the stability of the Tailings Basin embankment (see Section 4.13). Any increase in the beach width for geotechnical reasons, could expose more coarse tailings to oxygen and result in an increase in contaminant release.

- Current modeling assumes no interaction between NorthMet seepage with the underlying LTVSMC tailings. Experiments (RS54/46, SRK 2007; Day 2008; Day 2009) evaluating the interactions between NorthMet seepage and the underlying LTVSMC tailings show the following effects:

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[27] It is the position of the tribal cooperating agencies that groundwater contamination from the previous mining activities is still an issue near the LTVSMC 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.

  - Comparable (slightly more basic) pH between the NorthMet leachate and the LTVSMC tailings, so no metal leaching effects are expected due to differences in pH.

  - The LTVSMC tailings contain some calcium and mixed iron carbonates that produce elevated alkalinity, which may buffer the lower pH leachate from the NorthMet tailings.

  - The LTVSMC tailings appear to remove (e.g. sorption) certain constituents from the NorthMet leachate. On the other hand, seepage through the LTVSMC tailings could result in elevated hardness and alkalinity.

- Current modeling assumes an average tailings sulfur content of 0.13%. Predictions made from kinetic testing suggest that water reacting with NorthMet tailings could become acidic when sulfur content is between 0.14% to 0.17% (Day 2008). During the small scale plant testing, some of the tailings exceeded 0.13% sulfur and were within the critical sulfur range. As a result, these tailings could produce lower pH, which would increase metal mobility. Test work by both MnDNR and PolyMet have shown increased release of nickel and cobalt as pH begins to decrease.

- The hydrometallurgical process proposed by PolyMet is a proprietary patented process that has not been employed at a commercial scale. Predicted hydrometallurgical residue chemistry is based on laboratory and small scale pilot tests. As a result, the hydrometallurgical residue composition at the operational scale might be more variable (both in terms of physical and chemical properties) than that observed in the small scale plant tests to date (the scale up factor from the small scale plant to the proposed operational scale is 2,500:1). In addition, no settling data are available, which makes prediction of residue settling times and consolidation uncertain.

Surface Water Resources

This section discusses the effects of the Proposed Action 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 4.1-11:

- 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% 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% of the proposed Mine Site facilities with a drainage area of 54.4 mi^2;
- Station SW-005 is located on the Partridge River at a railway crossing, and downstream of 100% 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 4.1-54 summarizes the primary input assumptions for the XP-SWMM model.

As discussed in Section 4.1.1.3, the flow data available for the Partridge River have 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" metrics (i.e., deviation of volume runoff and coefficient of efficiency for the entire period of simulation [WY 1978-1987], which showed a reasonable degree of success). These two metrics, 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 of low flow. 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.

Table 4.1-54 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 inches for stockpile liner yield based on 30-year climate normal data (October 1, 1971 to September 30, 2001). Stream flow modeling reflect actual precipitation during Water Years 1978-1987	RS73A based on data from Climate Prediction Center of the National Weather Service
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 inches	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 inches 6.2 inches	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 (high) Average condition Dry condition (low)	Flow resulting from 10-year 24-hour storm Average annual flow Average 30-day low flow
Modified parameters	Catchment areas Subwatershed slopes Subwatershed widths Impervious percentages Infiltration parameters	ESRI GIS Area weighted from ESRI GIS Digitized average ESRI GIS Area weighted averages From soil types

Source: RS73A, Barr 2008

In order to assess the representativeness of the 1978-1987 period of simulation, precipitation occurring during this period was compared 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 one very wet year, several fairly average years, a relatively dry year, but no very dry years. Therefore, there is some uncertainty regarding the models predictions of dry extremes.

Effects on the Upper Partridge River

The Proposed Action 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's 100-year floodplain. These potential effects are evaluated below.[28]

Effects on Upper Partridge River Flows

The Proposed Action 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 to approximately 2.6% at the USGS gage above Colby Lake (Table 4.1-55). This mine facility drainage is effectively removed from the Partridge River watershed 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 effect of the Proposed Action on flow in the Upper Partridge River.

- Reducing the groundwater contribution to river flow by dewatering activities in the mine pits – PolyMet estimates the changes in average groundwater inflow during low flow periods (i.e., 30-day low flow) to the Partridge River as varying over mine years and location, but reaching a maximum reduction of only 0.16 cfs during Year 20 (Table 4.1-56. The reduction in groundwater contributions during average flow conditions is predicted to be 0.21 cfs (PolyMet, Comments on PDEIS, August 19, 2009). In both cases, the reduction in the groundwater contribution to river flow would be modest.

- 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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[28] 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.

Table 4.1-55 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 4.1-56 Average Reduction in Baseflow (30-day annual low flow) 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, Tables 2 through 7, RS73B, Barr 2008.

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 the effects of the Proposed Action on Partridge River flows in this DEIS focuses on the following:

- Location - SW-004 is the location where the maximum impact on flow occurs (Table 4.1-55. 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 between Years 15 to 20 when the footprint of the mine facilities would be near its maximum, reclamation of the stockpiles would be still underway (e.g., vegetation maturing), and the West Pit would be reaching its deepest elevation (Table 4.1-55). 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 Proposed Action 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.

The effects of the Proposed Action on flow in the Upper Partridge River were evaluated using the Richter range of variability approach during the driest year modeled under the High Impact Scenario (Table 4.1-57). 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, but which represent only a 0.2 to 2.1 cfs reduction 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 surface runoff and groundwater 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), the effects of the Proposed Action (in terms of percent reduction in flow) would be significantly reduced as a result of the South Branch's flow contribution.

In many cases, the large predicted monthly percent reduction in Upper Partridge River 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.

Table 4.1-57 Partridge River Flows – Hypothetical High Impact Scenario – 1979 Model Year[1]

Statistic	unit	SW-002			SW-003			SW-004			SW-004a			SW-005			USGS		
		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	-3.7
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	-8.0
Mean July flow	cfs	0.6	0.5	-16.7	0.7	0.6	-14.3	1.1	0.8	-27.3	2.7	2.4	-11.1	5.4	5.1	-5.6	6.0	5.7	-5.0
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	-13.0	8.5	8.0	-5.9	9.9	9.3	-6.1
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	-4.0	58.0	55.7	-4.0
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	-9.6	329.1	304.0	-7.6	526.0	503.5	-4.3	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	-20.7	0.41	0.32	-22.0	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	-20.7	0.41	0.32	-22.0	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	-19.3	0.45	0.35	-22.2	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	-22.2	0.87	0.68	-21.8	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	-21.0	1.12	0.88	-21.4	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	-12.5	0.066	0.065	-1.5	0.079	0.078	-1.3	0.082	0.081	-1.2
# of high pulses (HP)	#/year	6	6	0.0	5	5	0.00	5	5	0.0	7	7	0.0	5	5	0	5	4	-20.0
# of low pulses (LP)	#/year	14	14	0.0	15	15	0.00	8	9	12.5	11	11	0.0	11	11	0	11	12	9.1
Mean HP duration	days	9	9	0.0	10.6	10.4	-1.90	10.60	10.40	-1.9	7.9	7.7	-2.5	10.4	10.4	0	10.6	12.8	20.8
Mean LP duration	days	6.7	6.7	0.0	6.1	6.2	1.60	14.30	12.60	-11.9	11	11	0.0	11.9	11.9	0	11.6	10.9	-6.0

Source: RS73A, Barr 2008.

[1] Flows presented in this table reflect the High Impact Scenario, a hypothetical scenario reflecting larger than planned impact areas, during Model Year 1979, which is the driest year evaluated.

The predicted change in minimum and maximum extreme flows (1-day, 7-day, 30-day, and 90-day) in the Upper Partridge River 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 Proposed Action 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 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 4.1-22) than where it would occur otherwise. Further, as discussed in Section 4.1.3.1 (Effects on Groundwater Levels), there would be a localized 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).[29]

Effects on Upper 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 the effects of the Proposed Action on river morphology, reductions in the maximum annual one day flows (i.e., approximately 1.0-year recurrence interval) were evaluated 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 Proposed Action is predicted to result in less than a 10% reduction in Upper Partridge River annual maximum one day flows (Table 4.1-58).

This reduction in Upper Partridge River 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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[29] Tribal cooperators strongly disagree with the conclusions in this section. The available data does not support these conclusions.

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.[30]

Table 4.1-58 Project-related Reduction in Annual Maximum One Day Flows at SW-004 in the Upper 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

The other potential geomorphic effect of the Proposed Action would be at the outfall of the West Pit (Figure 4.1-22). 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, respectively (Appendix F, RS74A, Barr 2008). PolyMet would preferably form the West Pit outlet channel out of bedrock to minimize long term maintenance, or it could be cast-in-place with a reinforced

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[30] 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.

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. It is 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 Proposed Action 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. The Project would result in a net reduction in Partridge River flows, so would not affect downstream flood elevations.

Effects on Water Levels in Colby Lake and Whitewater Reservoir

Minnesota Power and Cliffs Erie LLC (to be replaced by PolyMet if approved by MnDNR) 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% of the time and 8,000 gpm about 1% of the time. The effect of these withdrawals on water levels in Colby Lake and Whitewater Reservoir are evaluated below. 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 – Water Years 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 4.1-59), withdrawals for the Proposed Action 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 4.1-59 Project Effects on Water Levels in Colby Lake and Whitewater Reservoir During Average Flow Conditions

	Colby Lake				Whitewater Reservoir			
Water withdrawal (gpm)	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 (ft)	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.

Under 50-year low flow conditions (Table 4.1-60), withdrawals for the Proposed Action would slightly 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 4.1-60 Project Effects on Water Levels in Colby Lake and Whitewater Reservoir During 50-Year Low Flow Conditions

	Colby Lake				Whitewater Reservoir			
Water withdrawal (gpm)	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 (ft)	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 water demands for the Proposed Action 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. The effects of the Proposed Action 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).

At Whitewater Reservoir under average conditions (i.e., 3,500 gpm), the increased water demand would result in shoreline retreat of less than 10 feet horizontally, except in two coves where the retreat could be as much as 75 feet (Figure 4.1-27; RS73B, Barr 2008). Under the 5,000 gpm demand scenario, shoreline retreat could be as little as 50 feet and as much as 250 feet in these coves. These increased water level fluctuations could affect lake access by waterfront residences and at the City of Hoyt Lakes Fisherman's Point Campground. There are, however, only 26 waterfront lots on Whitewater Reservoir, all of which are part of the Patriot's Point subdivision. Minnesota Power, who owns most of the waterfront property on Whitewater Reservoir and is developing the subdivision, is not selling these lots, but only entering into long-term leases. These leases include a Lease Program Disclosure Form that discloses to potential leasees that water level fluctuations could occur at any time and that there are no guarantees of reservoir elevations (www.shorelandtraditions.com). The seasonally used (May 1 - September 15) 70-campsite Fisherman's Point Campground has two boat ramps, two boat docks, and two fishing piers, all of which (except one fixed fishing pier on a small cove) are usable at relatively low water levels (Rich Bradford, City Administrator, personal communication). Under the 5,000 gpm demand scenario, water levels would retreat 50 feet beyond the end of the north boat ramp at Fisherman's Point Campground. Overall, the effects of increased water level fluctuations at Whitewater Reservoir on waterfront residences and the Fisherman's Point Campground would be minor and no greater than annual fluctuations that have occurred in the past (i.e., during LTVSMC operations, annual water level fluctuations in Whitewater Reservoir were as high as 14 feet, Table 4.1-16).

Effects on Flow in the Lower Partridge River Downstream of Colby Lake

The Proposed Action 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 Proposed Action would result in an average 9% 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 Proposed Action 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 (i.e., 13 cfs). The Proposed Action 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 (see Section 4.1.4.1 Cumulative Effects on Hydrology).

Effects on Flow in the Embarrass River

The Proposed Action would have no direct surface water discharge to, and would not change the drainage area of, 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 seepage from the Tailings Basin during Project operations, Closure, and Post-Closure. Under existing condition, seepage from the LTVSMC Tailings Basin (Cells 1E/2E) is estimated at approximately 900 gpm (2.0 cfs) (Hinck 2009).[31]

During Project operations, unrecoverable NorthMet groundwater seepage from the Tailings Basin Cells 1E/2E would vary from 1,600 to 2,900 gpm (up to approximately 6.5 cfs) (Table 4.1-35). This unrecoverable groundwater 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 groundwater seepage from Cells 1E/2E would be approximately 490 gpm (1.1 cfs) (Hinck 2009). This long-term steady state groundwater seepage would be approximately 45% 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%) compared to average annual flows in the Embarrass River (approximately 85.5 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%) compared to the average flow in the Embarrass River. Therefore, the effects of the Proposed Action on flow in the Embarrass River are considered negligible and should not affect downstream flood elevations.

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 direct 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 stockpile liners, the hydrometallurgical residue storage area, the Tailings Basin; and pit lake overflows. Recent hydrogeologic investigations of the Tailings Basin area show that there is not sufficient transmissivity in the downgradient aquifer to transmit the predicted seepage from the basin. As a result, the seepage upwells to the surface and affects surface water quality. The methodology used in modeling surface water quality and the predicted effects of the Proposed Action on surface water quality in the Project area are discussed below.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[31] 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.

Evaluation Methodology

The effects of the Proposed Action 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 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). Mercury is addressed separately later in this section.

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 attenuation in loadings during flow 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 the effects of the Proposed Action on Partridge River water quality.

Domestic 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 Proposed Action.

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 4.1-61 presents the estimated volume contributions from each of these sources to the Partridge River, 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 4.1-61 Summary of Unrecovered Seepage and Sump 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
Collected Liner leachate		
Category 1 and 2 stockpile sumps[2]	0.002083	0.002083
Category 3 stockpile sumps[3]	0.000008	0.000008
Category 3 lean ore stockpile sumps	0.000016	0.000016
Category 4 stockpile sumps	0.000007	0.000007
Lean ore surge pile sumps	0.000014	0
Unrecovered Liner Leakage[4]		
Category 1 and 2 and overburden[5]	586	426
Category 3 waste rock	0.127	0.0705
Category 3 lean ore	0.277	0.159
Category 4 waste rock	0.112	0.011
Lean ore surge pile	0.096	NA[6]
Process Water Ponds		
PW-1 Overburden Runoff Pond[1]	8.48	0
PW-2 Haul Road Runoff Pond	0.006028	0
PW-3 Rail Transfer Hopper Pond	0.000004	0
PW-4 Haul Road Runoff Pond	0.012917	0
PW-7 Overburden Runoff Pond[1, 3]	15.93	0
WWTF Equalization Ponds[7]	0.0132	0

Source: Modified from Table 4-3, 4-4, 4-5, 4-6, and 4-30, RS74A, Barr 2008.

1 No liner present.
2 Only the southern-most sump of the Category 1 and 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 Assumes 100% reclaimed stockpile
5 The high liner leakage rates for the Category 1 and 2 overburden stockpile exceeds the transmissivity of the aquifer. In this case, groundwater could start to mound in stockpile, bur should be collected by the liner drainage system and pumped to the WWTF.
6 The Lean Ore Surge Pile is a temporary stockpile and would be removed during closure.
7 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 monitoring of the discharge is recommended as part of any NPDES/SDS permit (see Section 4.1.3.5 for a discussion of recommended monitoring measures).

Stormwater runoff from the Processing 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. Section 4.1.3.5 discusses a potential mitigation measure that addresses this issue.

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 4.1-62. 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 the more downstream locations (i.e., SW-004, SW-004a, SW-005, and USGS gaging station).

All modeled constituents would meet in-stream surface 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 95th percentile solute loading values from the waste rock stockpile Uncertainty Analysis, some of which were higher than the values predicted in the deterministic modeling as discussed above. 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 Proposed Action is not predicted to result in any exceedances of surface water quality standards for the Partridge River at the modeled locations.

Table 4.1-62 Predicted Water Quality along the Upper Partridge River for the Proposed Action

Parameter	Units	Water Quality Standard	Existing Modeled Concentration[2]	Predicted Max Concentration	Location	Flow Conditions
General						
Chloride	mg/L	230	7.8	8.2	Multiple	Average Flow
Fluoride	mg/L	--	0.2	0.3	SW-004a	Low Flow
Hardness	mg/L	500	108	119	SW-004a	Average Flow
Sulfate	mg/L	--(3)	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	2.5(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
Iron	µg/L	--	2,384	2,349	SW-006	Low Flow
Lead	µg/L	2.9(1)	0.8	1.1	SW-004a	Low Flow
Manganese	µg/L	--	150	150	Multiple	High Flow
Nickel	µg/L	46.5(1)	1.9	25.6	SW-004	Low Flow
Selenium	µg/L	5.0	1.7	1.8	Multiple	Low Flow
Thallium	µg/L	0.56	0.40	0.40	Multiple	High Flow
Vanadium	µg/L	--	4.3	9.0	SW-004a	Low Flow
Zinc	µg/L	96.1(1)	24.2	24.6	USGS	Low Flow

Source: Tables 5-4 to 5-24, RS74A, Barr 2008
Note: Values in **bold** exceed applicable surface water standards.

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration at that location.

2 "Existing Modeled Conditions" reflect predicted existing concentrations for the various parameters under the applicable flow conditions based on available water quality monitoring and estimates of pollutant loads by source. Average existing water quality concentrations are presented in Table 4.1-24.

3 The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

West Pit Overflow

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. During Post-Closure, the West Pit would receive inflow from direct surface drainage, groundwater seepage (including liner leakage from the Category 1 and 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. The potential effectiveness of the proposed constructed wetland is evaluated below, and then, based on those conclusions, the likely water quality of the West Pit overflow is evaluated.[32]

Constructed Wetlands

PolyMet assumed wetland removal efficiencies in the East Pit passive wetland system would range from 50 to 80-90% for six parameters (Table 4.1-63). Constructed wetlands have proven effective in removing various pollutants, but the results have been 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. Metal removal effectiveness of these wetlands also had strong seasonal variability. Sulfate removal was highly variable.

Table 4.1-63 Estimated Wetland Removal Efficiencies

	PolyMet Estimate[1]			Dunka Mine Wetland	Mine Drainage Wetland	Constructed Wetland	
Parameter	**Low**	**Medium**	**High**	**Performance[2]**	**Performance[3]**	**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%	80%	Highly Variable	10-30%	--	--

1 Hinck and Wong 2008.
2 Appendix D, RS29T, Barr 2007.
3 Halverson 2004; Birch et al. 2006; Center for Watershed Protection 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 treating mine drainage and other pollutant sources (Table 4.1-63). In most cases, these wetlands were used to "polish" treated effluents and the incremental improvement they offer is valuable. This type of passive treatment is an important component of MnDNR's regulatory goal of minimizing or avoiding the need for long term

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

32 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.

maintenance. Constructed wetlands performance, however, is not sufficiently reliable to function as the primary treatment measure for assuring consistent year-round compliance with water quality standards.[33]

West Pit Overflow Water Quality

The deterministic modeling results predict that three parameters (i.e., arsenic, cobalt, and selenium) would exceed surface water quality standards when the West Pit overflows (Table 4.1-64). 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 of surface water standards for cobalt, copper, and nickel (Table 4.1-64). PolyMet states that these exceedances are the result of applying the constant solute production method instead of the exponential decay method for predicting solute loading from the pit wall (applies to cobalt and nickel) and excluding the effects of adsorption (applies to copper).

The Uncertainty Analysis did not consider the effect of adsorption on the concentration of copper in the West Pit, as was done in the deterministic modeling. Some sorption is expected to occur because of precipitation of iron and manganese oxides in the pit lake (RS31, Barr 2007). Consideration of adsorption would reduce the predicted copper concentration in the West Pit, (see Hinck and Wong, *Uncertainty Analysis Workplan Tab 4b Monte Carlo Simulation - Pit Flooding Geochemistry*, September 30, 2008), but it is unclear but to what extent sorption would occur within the water column versus the pit walls and floor.

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 five parameters (i.e., arsenic, cobalt, copper, nickel, and selenium) could exceed surface water quality standards, in addition to relatively high sulfate concentrations. The unnamed tributary to which the West Pit would discharge would essentially function as a mixing zone (Figure 4.1-22), but water quality standards may be exceeded. There is the potential that this overflow could result in a short reach (approximately 1,000 feet) of the Upper Partridge River between the confluence with the unnamed tributary and the South Branch Partridge River exceeding some surface water standards. 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-004a (located approximately 1,000 feet downstream from where the West

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[33] 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.

Table 4.1-64 Summary of West Pit Water Quality at Post-Closure under Proposed Action

Constituent	Units	Water Quality Standard	Deterministic Model	Uncertainty Analysis (90% probability)[3]
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	18.6	--
Antimony	ug/L	31	28.2(2)	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)	6.0	**464**
Iron	ug/L	--	100	--
Lead	ug/L	16.5(1)	6.5	--
Manganese	ug/L	--	10	--
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.

Note: Values in **bold** exceed surface water standards

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 364 mg/L.

2 The predicted antimony concentration was revised subsequent to the issuance of RS74A because the dissolution rate originally used was based on the NorthMet humidity cells, which were contaminated for antimony, rather than the MnDNR reactor data. See Hinck, Pint, and Wong; *Revised Model Results for Antimony at the Mine Site*, September 25, 2009.

3 90% probability means that there is a 90% probability that actual values will be equal to or less than the value predicted.

Pit overflow would reach the Partridge River and downstream of the confluence of the South Branch Partridge River) based on deterministic modeling (Table 4.1-62).[34] Section 4.1.3.5 discusses measures that could mitigate these potential surface water exceedances, such that, if implemented, water quality would be expected to meet surface water standards in the unnamed tributary and the Partridge River.

These exceedances also reflect the effects of an initial release of solutes from the flooding of the pit walls, which is expected to be a relatively short term effect. Water quality in the West Pit is expected to improve as oxidation would be negligible once the pit walls are submerged. The pit

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

34 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.

walls are predicted to be the primary source of the potential cobalt, copper, and nickel exceedances, and a major source of the potential arsenic exceedance. Section 4.1.3.5 discusses potential mitigation measures that address the potential for exceedances of surface water standards in the West Pit overflow.[35]

Colby Lake and Whitewater Reservoir Water Quality Results

The Proposed Action 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 Proposed Action 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 indirectly the City of Hoyt Lakes WWTP, which discharges to Whitewater Reservoir, the water from which can be pumped into Colby Lake. 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, manganese, and thallium, as shown in Table 4.1-65 (RS74A, Barr 2008).

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 2.2 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% arsenic removal efficiency for the East Pit treatment wetlands). Using the 90^{th} percentile cumulative probability, 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 and well below the primary MCL of 10 ug/L (Wenigmann and Wong 2009).

[35] 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.

Table 4.1-65 Predicted Water Quality at Colby Lake for the Proposed Action

Parameter	Unit	Standard	Existing Modeled Conditions[2]	Predicted Highest Concentration	Mine Year	Flow Conditions
General						
Chloride	mg/L	230	7.9	8.2	Post-Closure	Average flow
Fluoride	mg/L	2.0	0.1	0.1	Post-Closure	Average flow
Hardness	mg/L	500	109	113	Post-Closure	High flow
Sulfate	mg/L	250	10.1	15.3	Post-Closure	Low flow
Metals						
Aluminum	µg/L	50-200	76	76	Year 15	Low flow
Antimony	µg/L	5.5	1.5	3.9	Post-Closure	Low flow
Arsenic	µg/L	2.0	**2.2**	**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)	2.0	2.5	Year 15	High flow
Iron	µg/L	300	**1,717**	**1,713**	Year 1	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
Selenium	µg/L	5.0	0.7	0.8	Post-Closure	Low flow
Thallium	µg/L	0.28	**0.4**	**0.4**	All Years	All flows
Vanadium	µg/L	--	1.4	2.7	Post-Closure	Low flow
Zinc	µg/L	120(1)	18	18	Post-Closure	Low flow

Source: Tables 5-25 to 5-27, RS74A, Barr 2008
Note: Values in **bold** exceed applicable surface water standards.
1 Water quality standards for this metal is hardness-dependent. The listed values reflect a predicted hardness concentration of 100 mg/L.
2 "Existing Modeled Conditions" reflect predicted existing concentrations for the various parameters under the applicable flow conditions based on available water quality monitoring and estimates of pollutant loads by source. Average existing water quality concentrations are presented in Table 4.1-25.

The elevated iron and manganese concentrations are not attributable to the Proposed Action, but rather are related to the existing concentrations in the Partridge River. The Class 1B Minnesota water quality standard for iron is 300 µg/L and for manganese is 50 µg/L. The average concentrations of iron and manganese from surface water quality monitoring in 2004, 2006 and 2007 at SW-005 (immediately upstream of Colby Lake) were 1,990 µg/L and 200 µg/L, respectively (Table 4.1-24). Therefore, the surface water quality standard for iron and manganese would be exceeded even without the Proposed Action. Iron and manganese are secondary MCL standards and are readily removed at drinking water treatment facilities prior to distribution to the community. The City of Hoyt Lakes, which uses Colby Lake as a water supply source, is able to remove nearly all iron at its water treatment plant and iron is not considered an operations issue for the City. In the past, the City had some problems with manganese, but only during late summer under low oxygen levels where manganese would be released from Colby Lake sediments. The City installed a higher water intake that is used during low oxygen conditions, which has corrected this problem (Floyd Nelson, personal communication, October 1, 2009).

The elevated thallium concentration is also not attributable to the Proposed Action, 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 baseline 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 degree of certainty.

Based on the predicted surface water concentrations, it appears that aluminum may exceed the lower bound of the USEPA secondary MCL standard. As discussed in Section 4.1.2.2, however, the surface water standard applies to dissolved aluminum, while the predicted concentrations reflect total aluminum concentrations. It is expected that aluminum would comply with the dissolved water quality standards as Colby Lake has a neutral pH (Table 4.1-25), under which dissolved aluminum is normally found in low concentrations. Aluminum has not been an issue for the City of Hoyt Lakes, despite historic “elevated” concentrations (average concentration from surface water quality monitoring in 2004, 2006, and 2007 at SW-005 was 116 µg/L). In fact, the City treats the raw water from Colby Lake with alum, which probably adds aluminum to the water. The City is not required to monitor for aluminum.

Therefore, considering the above described assumptions, the Proposed Action is not expected to result in the exceedance of any surface water quality standards in Colby Lake.

Water Quality in the Lower Partridge River

The Proposed Action should not result in any new exceedances of surface water standards 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. All parameters are expected to meet surface water standards under all flow conditions for all mine years as is predicted for the Upper Partridge River and Colby Lake.[36]

Embarrass River Water Quality Results

Although the Tailings Basin is not designed to be overtopped or to have a discharge, the Proposed Action 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 4.1-23). Groundwater seepage from the Proposed Action, 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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[36] 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.

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 as measured in laboratory testing). 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 Pit 5 NW 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 4.1-66 for PM-12 (upstream of Project effects) and PM-13 (downstream of all Project effects).

At an upstream site, 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 parameters are expected to meet surface water quality standards during all flow conditions for all modeled scenarios under the Proposed Action.

Predicted aluminum concentrations appear 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 433 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. Therefore, the predicted aluminum concentrations is not expected to exceed the surface water standard.

Table 4.1-66 Predicted Water Quality along the Embarrass River for the Proposed Action

Parameter	Units	PM-12				PM-13			
		Standard	Modeled Existing Conditions[4]	Predicted High Concentration	Flow Conditions	Standard	Modeled Existing Conditions[4]	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	--	0.8	1.7	Low Flow
Hardness	mg/L	500	82.6	82.6	Low Flow	500	255	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(5)	346(5)	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	2.1(2)	0.2	0.2	Low Flow	5.1(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	20.7(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	102(2)	16.0	16.0	High Flow	264(3)	12.6	34.5	Low Flow

Source: Barr 2008, *External Memorandum: Changes to the Tailings Basin Flows in the Embarrass River Watershed – 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*

Note: Values in **bold** indicate an exceedance in water quality standards. In this case, no exceedances are predicted.

1 The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

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.

4 "Existing Modeled Conditions" reflect predicted existing concentrations for the various parameters under the applicable flow conditions based on available water quality monitoring and estimates of pollutant loads by source. Average existing water quality concentrations are presented in Table 4.1-29.

5 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

The deterministic model predicts that the Proposed Action 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 in Post-Closure (i.e., 96 mg/L). A Culpability Analysis was conducted to determine the relative contribution of various contaminant sources on the deterministic water quality predictions. The analysis indicates that groundwater 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 Pit 5NW (nearby inactive taconite pit) and natural surface runoff from the watershed represent the primary sources of sulfate, respectively.[37] During low flow conditions, discharge from Pit 5NW is reduced and for modeling purposes was assumed to be 0.26 cfs, which corresponds to the lowest measured discharge during monitoring between 2001 and 2007 (Barr 2007, *Changes to the Tailings Basin Flows in the Embarrass River Watershed - PolyMet RS74*, dated October 14, 2008)

In summary, water quality modeling indicates that the Proposed Action is expected to meet surface water standards in the Embarrass River.[38]

<u>Waters That Contain Wild Rice</u>

The *Natural Wild Rice in Minnesota* report (MnDNR 2008) identifies mining and other industrial activities as potential stand-level threats to natural wild rice in Minnesota, primarily as a result of hydrologic changes and water quality impacts that can adversely affect wild rice. The estimated effects of the Proposed Action on each of the identified wild rice areas (Figure 4.1-15) are summarized in Table 4.1-67 and discussed below.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[37] 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.

[38] It is the position of the tribal cooperating agencies that 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.

Table 4.1-67 Effects of the Proposed Action on Wild Rice Areas

Wild Rice Areas	Density Factor	Measured Sulfate Concentration[1]	Water Quality Effect Predicted/Estimated Sulfate Concentration – Average Flow[2]	Hydrologic Effect
Partridge Watershed				
Upper Partridge River	1	5-6 mg/L	10 -14 mg/L (at SW-005)	Reduce critical annual 7-day low flow by only 0.14 cfs at SW-005 (Table 4.1-57)
Lower Partridge River	3-5	47-289 mg/L	Estimate of 1 to 2 mg/L increase accounting for dilution	Reduce average flow from Colby Lake by 10.5 cfs (9%)
Embarrass Watershed				
Embarrass River	1	33 mg/L	Average of 53 mg/L (at PM-13)	Increase in average flow of 4.5 cfs – seepage rate would be relatively constant over a single growing season so negligible effect on water levels
Hay Lake	1	2 mg/L	No effect – tributary to Embarrass River	No effect Tributary to Embarrass River
Sabin Lake	1	Not Available – Estimated as 29 mg/L	Estimate of 46 mg/L due to dilution, deposition and biological uptake	Negligible effect Lake would attenuate any water level fluctuations
Wynne Lake	1	Not Available – Estimated as 25 mg/L	Estimate of 40 mg/L due to dilution, deposition, and biological uptake	Negligible effect Upstream lakes would attenuate any water level fluctuations
Embarrass Lake	1	21 mg/L	Estimate of 34 mg/L due to dilution, deposition, and biological uptake	Negligible effect Upstream lakes would attenuate any water level fluctuations
Lower Embarrass Lake	1	21 mg/L	Estimate of 34 mg/L due to dilution, deposition, and biological uptake	Negligible effect Upstream lakes would attenuate any water level fluctuations
Unnamed Lake	1	21 mg/L	Estimate of 34 mg/L due to dilution, deposition, and biological uptake	Negligible effect Upstream lakes would attenuate any water level fluctuations
Cedar Island Lake	1-5	20 mg/L	Estimate of 32 mg/L due to dilution, deposition, and biological uptake	Negligible effect Upstream lakes would attenuate any water level fluctuations
Esquagama Lake Outlet	1	17 mg/L	Estimate of 27 mg/L due to dilution, deposition, and biological uptake	Negligible effect Upstream lakes would attenuate any water level fluctuations

1 "Measured" sulfate concentration was measured during the wild rice field survey.
2 Predicted sulfate concentrations used in this analysis represent average flow conditions, so sulfate concentrations presented here will vary from concentrations presented elsewhere in this DEIS where low flow conditions are referenced.

In the Upper Partridge River, the Proposed Action would have little hydrologic effect on wild rice in terms of changes in flows or water levels relative to existing conditions. In the Lower Partridge River, average flows would be decreased by up to 10.5 cfs during Project operations. This hydrologic impact may be offset to some extent by increased discharges from the proposed Mesabi Nugget Phase II Project (see Section 4.1.4 – Cumulative Effects on Water Resources). The Proposed Action would increase, however, sulfate concentrations in the Partridge River via groundwater seepage from the waste rocks stockpiles, pit lakes, groundwater seepage from Cell 1E in Closure, and eventually (approximately Year 65) the West Pit overflow. Sulfate concentrations are predicted to increase in the Upper Partridge River from approximately 9 mg/L to about 14 mg/L under average flow conditions. In the Lower Partridge River, the predicted sulfate concentrations in water flowing from Colby Lake (approximately 13 mg/L) would have little effect on the elevated sulfate concentrations (average of 149 mg/L) found in the Partridge River downstream of Second Creek.

In the Embarrass River, the Proposed Action would have little hydrologic effect on wild rice in terms of changes in flows or water levels relative to existing conditions. The increased seepage from the Tailings Basin would be relatively constant over a single growing season and should have little if any effect on water levels at wild rice stands. Further, most of the wild rice is located downstream in the Embarrass Chain of Lakes, where any small changes in hydrology would be attenuated by the lakes. Existing sulfate concentrations are already elevated in the Embarrass River (i.e., average flow sulfate concentrations at PM-13 are 36 mg/L) because of overflow from Pit 5NW (average sulfate concentration of 1,046 mg/L) and seepage from the LTVSMC Tailings Basin (average sulfate concentration of approximately 155 mg/L – Table 4.1-7). The Proposed Action would increase sulfate concentrations under average flow conditions at PM-13 to 53 mg/L. This increase in sulfate concentration would be attenuated in the downstream lakes, but would still result in increases in increases of 9 to 11 mg/L.

Mercury in Surface Waters

Mercury can be released to surface or groundwaters through mobilization of mercury stored in rock, soil, peat, and vegetation. 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. Mercury concentrations in fish sampled from downstream lakes presently trigger advice to limit fish consumption. An increase in mercury bioavailability would be counter to state-wide efforts to reduce mercury concentrations in fish. This section discusses mercury from only a water quality perspective; the potential effects of the Proposed Action on the bioaccumulation of methylmercury in fish are discussed in Section 4.5.

Direct Release of Mercury to Waterbodies from the Mine Site

The potential for mercury to be released to waterbodies by exposing rock that contain mercury and the clearing of vegetation (primarily peat) is evaluated below.

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, the data suggest that mercury present in rainfall or released by sulfide oxidation is typically absorbed by other minerals present in the 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, such as proposed excavation and stockpiling of peat at the Mine Site, resulting in oxidation and decomposition of the peat may 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 1,536 acres (RS73B, Barr 2008). 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 excavated peat in either the Category 1 and 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 flooding 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% (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 NorthMet 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 it would be primarily pumped to help flood the East Pit. Consequently, the benefit of mercury removal in the tailings would be reduced. 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 (i.e., further reduce concentrations of metals). There is very limited data regarding the effectiveness of constructed wetlands in removing mercury. Experimental data indicate low removal rates of mercury in natural wetlands receiving municipal effluent (Kadlec and Knight 1996). The available water quality monitoring at the Dunka Mine constructed wetlands, showed total mercury removal rates varying from 0 to 75% (Appendix D, RS29T, Barr 2007). Based on the scientific literature, the constructed wetlands would be expected to be variably effective in removing total mercury, and could function as a source for methylmercury production. Despite mercury removal under certain conditions, any methylmercury production is undesirable.

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, concerns exist regarding the potential mercury concentration in the West Pit. PolyMet estimates that mercury concentrations in the West Pit overflow, which would be considered a discharge, would likely be less than the Great Lakes Initiative standard for mercury (1.3 ng/L) based on batch testing and experience at other mine pits in the Project area. PolyMet conducted batch tests to simulate the effects of mine area rock on pit water chemistry using local rainfall (~12 ng/L total mercury) and the test results indicated that contact with Duluth Complex rock 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 additional analysis of this issue is recommended.[39] Section 4.1.3.5 discusses potential mitigation measures that address potential exceedances of mercury concentrations in the West Pit overflow.

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 107.5 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 Proposed Action, 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% of the mercury in the ore entering the Processing 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 Minntac 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 baseline levels (Table 4.1-31), 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).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[39] 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.

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%) 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 in aquatic systems where sulfate is limiting (Gilmour et al. 1992; Krabbenhoft et al. 1998). Although the Proposed Action is expected to result in a negligible release of inorganic mercury to surface or groundwaters, it could enhance methylation efficiency. There are several factors that appear to influence mercury methylation including total available mercury, organic carbon, temperature, and micronutrients required by sulfate-reducing bacteria, but the two most important factors that could be affected by the Proposed Action appear to be increasing sulfate loadings (over the range for which sulfate may be a limiting factor) and/or creating hydrologic conditions that enhance methylation. These two potential effects are 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 one of several limiting factors for the methylating bacteria (Jeremiason et al. 2006; Watras et al. 2006). Adding sulfate to aquatic systems where sulfate is limited 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 where sulfate may no longer be limiting (Mitchell et al. 2008). Water may transport sulfate to other downstream locations, however, where sulfate availability is rate limiting for 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 Balogh 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 MnDNR 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 from wetlands during storm events.

The Proposed Action would result in increased sulfate loadings via groundwater to both the Partridge and Embarrass rivers. At the Mine Site, there are few wetlands located between the waste rock/lean ore stockpiles and the Partridge River, so there is little opportunity for sulfate-wetland interactions.[40] Further, the predicted sulfate concentration in the Partridge River would remain relatively low (increasing from an existing average of approximately 10 mg/L to a predicted range of 10.1 to 14.1 mg/L under average flows in the Upper partridge River [SW-004 to the USGS gage]) and, based on NWI maps, 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 from the Mine Site promoting methylation of mercury in wetlands is expected to be low.[41]

The groundwater seepage rate from the Tailings Basin would exceed the aquifer flux capacity, so much of the groundwater 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 favorable 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 the potential for mercury methylation both in the wetlands north of the Tailings Basin and at the downstream lakes.

It should be noted, however, that the predicted sulfate concentrations in the Tailings Basin seepage, which would range from 149 to 241 mg/L during mine operations and closure (Table 4.1-50), are similar to existing sulfate concentrations from the LTVSMC tailings measured at the toe of the Tailings Basin, which average 155 mg/L, but ranges from 13 to 555 mg/L (Table 4.1-7). Limited monitoring indicates that methylmercury levels north of the Tailings Basin (PM-13 with an average sulfate concentration of 36.1 mg/L and an average methylmercury concentration of 0.25 ng/L) are less than at the upstream monitoring station not affected by mining (PM-12, with an average sulfate concentration of 4.6 mg/L and an average methylmercury concentration of 0.59 ng/L), which suggests that the sulfate in the Tailings Basin seepage is not promoting significant mercury methylation, perhaps because sulfate is not the limiting factor in this location. Since the predicted sulfate concentrations are similar to existing sulfate concentrations, the Proposed Action may not result in a measurable increase in methylmercury production in the wetlands north of the Tailings Basin on the Embarrass River. This sulfate could, however, promote mercury methylation downstream. PolyMet is conducting additional sampling in the wetlands, streams, and downstream lakes under a MPCA approved plan to help better understand mercury dynamics in the Project area.

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

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[40] 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.

[41] 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.

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 the 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 some of 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 Proposed Action 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.[42] Similarly, water level fluctuations in Colby Lake are expected to be less with the Proposed Action than under natural conditions (Tables 4.1-58 and 4.1-59) 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 is not expected to result in significant increases in mercury methylation.

<u>Nondegradation Standards</u>

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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[42] It is the tribal cooperating agencies' position that the data used to support this conclusion is inadequate.

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.

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 (see Section 4.1.3.5 for a discussion of recommended monitoring measures).[43]

Effects on Surface Water Rights and Uses

A Water Appropriation 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 Cliffs Erie's share of the Water Appropriation Permit to PolyMet so it can obtain process water from Colby Lake, pending MnDNR approval. This Permit has a stipulation that withdrawals from Colby Lake cannot 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 the Proposed Action (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, but the fluctuations would be less than the range recorded during LTVSMC operations.

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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[43] 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.

Summary of the Proposed Action

Table 4.1-68 provides a summary of the primary water resource effects of the Proposed Action. At the Mine Site, the permanent surface storage of the most reactive waste rock could result in long term exceedances of groundwater evaluation criteria for several parameters. Long term active treatment of residual seepage would be required, which would not achieve the State's goal of closing a mining facility so that it is maintenance-free.

The groundwater 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 elevated sulfate concentrations. This upwelling would inundate portions 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 affect sulfate concentrations in downstream waters that contain wild rice.

Table 4.1-68 Water Resources Impact Summary for the Proposed Action

Key Potential Issues	Effects of the Proposed Action	Reference Page Number
Groundwater levels at the Mine Site	Drawdown expected during mine operations and filling of West Pit (~65 years).	4.1-59
Groundwater quality at the Mine Site	Antimony, manganese, nickel, and sulfate predicted to exceed groundwater evaluation criteria, potentially for long term.	4.1-65
Flows in the Upper Partridge River	Reduce average flow by approximately 1.5 cfs. Minimal reduction in annual 7-day low flow (~0.1 cfs). No significant effect on river morphology or 100-year floodplain.[44]	4.1-98
Water quality in the Upper Partridge River	All parameters predicted to meet all surface water quality standards at all locations during all flow conditions for all mine years. West Pit overflow in Closure is predicted to initially exceed standards for several parameters, but water quality is expected to improve over time and exceedances could be mitigated.[45]	4.1-108
Water levels in Colby Lake & Whitewater Reservoir	Negligible increase (0.03 ft) in average water level drawdown and improvement in maximum annual fluctuation and % days below critical elevation at Colby Lake. Water level fluctuations and average drawdown would increase at Whitewater Reservoir relative to existing conditions, but would be no greater than when LTVSMC was operating.	4.1-104
Water quality in Colby Lake & Whitewater Reservoir	All parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.	4.1-115
Flows in the Lower Partridge River	Reduce average flows by as much 10.5 cfs (9%) and increase the frequency of low flows.[46]	4.1-106

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[44] Tribal cooperating agencies disagree with these conclusions because there is insufficient data.
[45] Tribal cooperating agencies note that the west pit is predicted to violate surface water standards for all years that predictions were made.
[46] Tribal cooperating agencies disagree. There is not enough data to support this conclusion.

Key Potential Issues	Effects of the Proposed Action	Reference Page Number
Water Quality in Lower Partridge River	All parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.[47]	4.1-117
Groundwater levels downgradient of the Tailings Basin	Groundwater seepage would exceed aquifer flux capacity resulting in significant seepage upwelling and wetland impacts.	4.1-63
Groundwater quality downgradient of the Tailings Basin	Groundwater seepage from the Tailings Basin would generally meet groundwater evaluation criteria with the possible exception of aluminum. Aluminum is a USEPA secondary MCL standard for managing aesthetic considerations and not to protect human health, and is naturally found in elevated concentrations in the Project area.[48]	4.1-86
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.	4.1-106
Water quality in the Embarrass River	All parameters predicted to meet surface water quality standards during all flow conditions for all mine years.[49]	4.1-117
Waters That Contain Wild Rice	Increase in hydrologic variability and about a 1 to 2 mg/L increase in sulfate concentrations in the Lower Partridge River, although sulfate concentrations are already elevated in this area (>100 mg/L). Negligible effect on seasonal hydrology of the Embarrass River, but an increase in sulfate concentrations under average flows of up to 20 mg/L predicted at PM-13, although sulfate concentrations are already somewhat elevated in this area (33 mg/L).	4.1-120
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, but this impact could be mitigated if it would occur.	4.1-122

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[47] Tribal cooperating agencies disagree. The wild rice standard for sulfate and the Lake Superior standard for mercury would be exceeded.
[48] Tribal cooperating agencies disagree. Existing contamination has not been considered in the analysis.
[49] Tribal cooperating agencies take the position that the wild rice sulfate standard is applicable and would be exceeded.

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 baseline) concentrations of several parameters including aluminum, fluoride, 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 monitoring data that are available do not suggest regular exceedances of groundwater evaluation criteria at downgradient evaluation points (e.g., property boundary).[50]

The Closure Plan for the LTVSMC Tailings Basin calls for regrading (to attempt to create wetlands in low areas), vegetative restoration, and water quality monitoring as required by NPDES/SDS Permit #MN0054089. The Closure Plan does not propose any remediation of groundwater seepage from the Tailings Basin.[51] It is, however, expected that groundwater issues would be addressed by the MPCA during the reissuance of the NPDES/SDS permit for this site.

Over 60 AOCs have been identified at the former LTVSMC property (Tables 4.1-9 and 10). Several of these have been closed through the MPCA's VIC program, and many others are at various stages of completion within this program. With few exceptions, the sites that have been investigated 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. The remaining AOCs will be investigated and remediated as required. One-time monitoring in 2009 by Cliffs Erie of all flowing seeps and monitoring wells showed no evidence of any organic contamination (e.g. PCBs, volatile organic compounds).

It is difficult to estimate what effect any remediation activities may have on groundwater quality at the Tailings Basin. Over time, groundwater quality would be expected to approach baseline

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[50] 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.

[51] 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.

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.[52]

Effects on Surface Waters

Under the No Action Alternative, flows in the Partridge River, 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 (relative to baseline) of some parameters (e.g., sulfate) will continue to occur along the Embarrass River. Under existing low flow conditions, approximately 66% of the sulfate load in the Embarrass River at location PM-13 is attributable to the LTVSMC Tailings Basin, while Pit 5NW accounts for approximately 30%. Under average flow conditions, the Pit 5NW overflow accounts for about 69% of the sulfate load, while under high flows surface runoff is the major contributor of sulfate (55%) with the Pit 5NW accounting for 34%.

Existing seepage from the LTVSMC Tailings Basin is estimated as 1,795 gpm (about 4 cfs), but this rate is expected to decrease over time as the Tailings Basin continues to dewater, eventually reaching a relatively steady-state seepage rate of 1,100 gpm (about 2.4 cfs).

Pit 5NW and the LTVSMC Tailings Basin clearly represent the major anthropogenic sources of sulfate to the Embarrass River. Corrective actions at these sites, as may be required by the reissuance of existing NPDES/SDS permits, could reduce sulfate loadings and may enable sulfate concentrations in the Embarrass River near PM-13 to eventually approach that found at the upstream location PM-12.[53]

Waters That Contain Wild Rice

The No Action Alternative would have no effect on waters that contain wild rice in the Partridge or Embarrass rivers. There would be no Project-related hydrologic or water quality changes. Pit 5NW and the LTVSMC Tailings Basin would continue to contribute sulfate to the Embarrass River. Corrective actions at these sites, as may be required by the reissuance of the existing NPDES/SDS permits, could reduce sulfate loadings.

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[52] 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.

[53] 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 groundwater 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), which 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 according to MPCA guidance (2006). Available monitoring data for location PM-11, which is a stream draining a wetland that receives seepage from the Tailings Basin, does not indicate elevated methylmercury concentrations (average sulfate concentration of 88 mg/L and average methylmercury concentration of 0.25 ng/L) compared to location PM-12, which is unaffected by mining (average sulfate concentration of 4.6 mg/L and average methylmercury concentration of 0.59 ng/L). PolyMet is conducting additional sampling in the wetlands, streams, and downstream lakes under a MPCA approved plan to help determine whether streams draining wetlands near the Tailings Basin have more elevated methylmercury concentrations than streams draining wetlands in non-mining areas and the likely source of methylmercury in lakes downstream of the Tailings Basin (i.e., methylmercury generated in the lakes versus from wetlands in the watershed).

Summary of the No Action Alternative

Table 4.1-69 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 occur at the Mine Site. 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, creating what MPCA guidance describes as a high risk situation for mercury methylation.

Table 4.1-69 Water Resource Impact Summary of the No Action Alternative

Key Potential Issues	Effects of the No Action Alternative	Reference Page Number
Groundwater levels at the Mine Site	No effect	Not Applicable
Groundwater quality at the Mine Site	No effect	Not Applicable
Flows in the Upper Partridge River	No effect	Not Applicable
Water quality in the Upper Partridge River	No effect	Not Applicable
Water levels in Colby Lake and Whitewater Reservoir	No effect	Not Applicable

Key Potential Issues	Effects of the No Action Alternative	Reference Page Number
Water quality in Colby Lake & Whitewater Reservoir	No effect	Not Applicable
Flows in the Lower Partridge River	No effect	Not Applicable
Water quality in the Lower Partridge River	No effect	Not Applicable
Groundwater levels downgradient of the Tailings Basin	Groundwater seepage would exceed aquifer flux capacity resulting in continued seepage upwelling and wetland impacts, but at a reduced level relative to existing conditions as Tailings Basin continues to dewater and reach a relatively steady state.[54]	4.1-130
Groundwater quality downgradient of the Tailings Basin	Anticipate slight improvement in groundwater quality as Areas of Concern are investigated and remediated as appropriate.[55]	4.1-130
Flows in the Embarrass River	Slight (1.6 cfs) reduction in base flow as a result of gradually reduced seepage rate from LTVSMC Tailings Basin.	4.1-132
Water quality in the Embarrass River	Potential slight improvement in water quality as Areas of Concern are investigated and remediated as appropriate.	4.1-132
Waters That Contain Wild Rice	No effects on hydrology or water quality in the Partridge River. Negligible effect on seasonal hydrology and a modest long-term improvement in sulfate concentration expected in the Embarrass River.	4.1-132
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, creating what MPCA guidance describes as a “high risk situations” for mercury methylation, although at a slightly lower rate than under existing conditions.	4.1-133

4.1.3.3 Mine Site Alternative

Under the Mine Site Alternative, all Category 2, 3, and 4 (rather than Category 1 and 2) waste rock would be used to fill the East Pit in order to minimize the duration that the more reactive sulfide-bearing rock would be allowed to oxidize in surface stockpiles, thereby virtually eliminating long-term sulfide oxidation and associated solute release. PolyMet proposes to add limestone to the temporary stockpiles (Category 2 and 3 waste rock, Category 3 lean ore, and Category 4 waste rock) using multiple dosing stages and several mixing methods to neutralize acid formation until the rock can be backfilled into the East Pit beginning in Year 12 (Barr, *Draft Workplan for Uncertainty Analysis of the NorthMet Project Reasonable Alternative 1*,

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[54] 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.

[55] 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.

February 2, 2009). 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 close monitoring of the pH and water quality of collected leachate from these stockpiles is recommended to ensure the effectiveness of the lime treatment (see Section 4.1.3.5 for a discussion of recommended monitoring measures).[56]

The only permanent stockpiles would be for Category 1 waste rock and overburden. The Mine Site Alternative incorporates a change in the sulfur cutoff value for the Category 1 waste rock stockpile such that only waste rock with a sulfur concentration of less than 0.12% would be placed in the Category 1 stockpiles. All higher sulfur bearing waste rock would be subaqueously placed in the East Pit. 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 3.2-1). 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 (reference); care would be taken to ensure that the liner system would not be damaged during the conversion and remain functional, but only a vegetated soil layer would be installed.[57] In order to minimize the risk of accidental tears of the underlying geomembrane liner during the removal of the reactive waste rock, a thicker overliner is recommended (see Section 4.1.3.5 for a discussion of recommended mitigation measures).

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 to the WWTF for additional treatment for approximately 30 years (Years 21-50). 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.[58] 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 effects on groundwater levels at the Mine Site and in the area surrounding the Mine Site are expected to be approximately the same as for the Proposed Action.[59] The Mine Site Alternative would not

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[56] 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.
[57] The tribal cooperators take the position that the effectiveness of the evapotranspiration caps (i.e., vegetated soil layer) 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).
[58] As previously discussed, the tribal cooperating agencies' position is that the effectiveness fo the wetland treatment system is in doubt.
[59] 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.

significantly affect the water budget for the Project, so the effects 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 compared to the Proposed Action.

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 estimate of liner leakage because it assumes a combined worst case scenario (Section 4.1.3.1). For the Proposed Action, reservations existed about relying on just the low and average liner leakage rates for groundwater quality predictions, as it may not fully account for the essentially permanent use of the liner (e.g., liner degradation over time, differential settlement, and accidental tears during waste rock placement). Those same reservations do not exist about using the average liner leakage rate for the Mine Site Alternative because the more reactive waste rock (i.e., Category 2, 3, and 4) 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, although less reactive Category 1 waste rock would still be permanently stored on these geomembrane liners. Concerns still exist regarding the adequacy of the proposed overliner buffer 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. Section 4.1.3.5 discusses a potential mitigation measure for this issue. Therefore, the groundwater quality modeling results were evaluated using just the low and average liner leakage rates.

A steady state flow model was first used to assess the transport of all solutes under the liner leakage scenarios 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, values no higher than the low range of the USEPA Sorption Screening Level Values are accepted for arsenic, copper, and nickel, but not for antimony even though the testing did show some sorption occurring (Table 4.1-43).

The modeling assumed that all oxidized solutes would be leached during flooding of the East Pit, although concentration caps corresponding to a pH of 8 were applied. PolyMet would add limestone to the stockpiles or lime to the East Pit, if necessary, in order to maintain neutral to basic pH conditions. The modeling also 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 4.1-70 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 baseline concentrations that were not attributable to the Project and these solutes were not carried forward for detailed transient flow modeling.

Table 4.1-70 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*	Sulfate
#6 - Category 2 and 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* are predicted to potentially exceed groundwater evaluation criteria and are carried forward for transient flow modeling. Constituents in *italics* were not carried forward to transient modeling because the predicted exceedance is attributable to high baseline concentrations.

Those solutes that were identified as potentially exceeding groundwater evaluation criteria (Table 4.1-70) using the initial steady state modeling, as well as sulfate, were then subjected to more detailed analysis using transient flow modeling. Table 4.1-71 provides a summary of the results showing that only antimony (from the Category 1 and overburden stockpile, West Pit, and Category 2 and 3 stockpile) would exceed groundwater evaluation criteria.

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). 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.

Table 4.1-71 Summary of Maximum Concentrations Predicted Using Deterministic Transient Flow Modeling at the Mine Site under the Mine Site Alternative

Parameters	Unit	Evaluation Point[1]	Groundwater Evaluation Criteria	Liner Leakage Model(s) with Criteria Exceeded[2]	Predicted Model Maximum Concentration[3]	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**[(5)]	~100 to 2,000	**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**[(4) (5)]	~520 to 2,000	**7.2**[(4)]
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	300	None	40	NA	40
Sulfate	mg/L	Partridge River	250	None	14	NA	14
Flow Path #4 – East Pit & Category 4 Waste Rock 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 3 Lean Ore Stockpile							
Sulfate	mg/L	Partridge River	250	None	14	NA	14
Flow Path #6 - Category 2 and 3 Waste Rock Stockpile							
Antimony	µg/L	Partridge River	6	Low, Average	**8.6**[(5)]	~125 to 2,000	**8.6**
Arsenic	µg/L	Partridge River	10	None	2.1	NA	13.0
Iron	µg/L	Partridge River	300	None	490	NA	490
Manganese	µg/L	Partridge River	300	None	57	NA	57
Sulfate	mg/L	Partridge River	250	None	213	NA	213

Source: Tables 8-24 and 8-25, RS74A, Barr 2008.

Note: Values in **bold** exceed groundwater evaluation criteria.

1. The Partridge River Groundwater Evaluation Point reflects groundwater directly upgradient from the Partridge River and does not include water flowing in the river, which would be subject to surface water quality standards.
2. The High liner leakage scenario was not considered reasonable for the Mine Site Alternative.
3. Predicted concentrations assume sorption of arsenic, copper, and nickel using the K_d values presented in Table 4.1-43.
4. Predicted antimony concentration was revised subsequent to the issuance of RS74A because the dissolution rate originally used was based on the NorthMet humidity cells, which were contaminated for antimony, rather than the MnDNR reactor data. See Hinck, Pint, and Wong; *Revised Model Results for Antimony at the Mine Site*, September 25, 2009.
5. The predicted antimony concentrations rely on the concentration cap developed from the contaminated humidity cell testing (80 µg/L) rather than MnDNR reactor data (3 µg/L), which probably results in overestimated of antimony concentrations in groundwater at the Mine Site.

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 4.1-72). Under the Mine Site Alternative, the only exceedances of groundwater evaluation criteria would possibly be antimony.

Table 4.1-72 Comparison of Exceedances of Groundwater Evaluation Criteria for the Proposed Action and Mine Site Alternative at the Mine Site

Parameters	Proposed Action Flow Paths[1]	Mine Site Alternative Flow Paths[2]
Antimony	Category 1 and 2 waste rock stockpile[3] West Pit East Pit & Category 4 waste rock stockpile[3] Category 3 waste rock stockpile	Category 1 waste rock stockpile[3] West Pit[3] Category 2 and 3 waste rock stockpile[3]
Arsenic	No exceedances (assuming sorption)	No exceedances
Copper	No exceedances (assuming sorption)	No exceedances
Manganese	Category 3 waste rock stockpile	No exceedances
Nickel	West Pit[4] Category 3 lean ore stockpile Category 3 waste rock stockpile	No exceedances
Sulfate	Category 1 and 2 waste rock stockpile[5] West Pit[4] 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.

1 Based on the results of both the deterministic modeling and the Uncertainty Analysis.

2 Based on the results of only the deterministic modeling. No Uncertainty Analysis was conducted for the Mine Site Alternative.

3 Antimony may not exceed groundwater evaluation criteria at this Flow Path when use of the concentration cap from the contaminated humidity cells is accounted for.

4 This parameter is only predicted to exceed groundwater evaluation criteria under the Uncertainty Analysis, not the deterministic model.

5 This parameter is only predicted to exceed groundwater evaluation criteria under the deterministic model, not the Uncertainty Analysis.

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 4.1-73. All constituents meet minimum in-stream Minnesota water quality standards at all locations in the Upper Partridge River during low, average and high flow conditions for all modeled scenarios under the Mine Site Alternative (RS74A, Barr 2008).

Table 4.1-73 Predicted Water Quality along the Upper Partridge River for the Mine Site Alternative

General Parameter	Unit	Partridge River Standard	Partridge River Maximum Concentration	Partridge River Location	Colby Lake Standard	Colby Lake Maximum Concentration
Chloride	mg/L	230	9.9	SW-004a	230	8.7
Fluoride	mg/L	--	0.3	USGS	2.0	0.1
Hardness	mg/L	500	114	SW-004a	500	114
Sulfate	mg/L	--	33.1	SW-004a	250	15.8
Metals - Total						
Aluminum	µg/L	125	114	USGS	50-200	76(2)
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	2.5(1)	0.1	Multiple	2.5(1)	0.1
Cobalt	µg/L	5.0	1.6	USGS gage	2.8	0.8
Copper	µg/L	9.3(1)	3.4	SW-004a	9.3(1)	2.1
Iron	µg/L	--	2,348	USGS gage	300	**1,713**
Lead	µg/L	3.2(1)	1.2	Multiple	3.2(1)	0.7
Manganese	µg/L	--	150	Multiple	50	**149**
Nickel	µg/L	52(1)	15.2	USGS gage	52(1)	4.6
Selenium	µg/L	5.0	2.0	Multiple	5.0	0.9
Thallium	µg/L	0.56	0.4	Multiple	0.28	**0.4**
Vanadium	µg/L	--	7.0	SW-004a	--	NA
Zinc	µg/L	120(1)	24.9	USGS	120(1)	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 100 mg/L.

2 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

The modeling results appear to indicate that the maximum concentration for several parameters at Colby Lake could exceed surface water standards (Table 4.1-73), but the apparent exceedances for iron and manganese are related to the high baseline concentrations and the exceedance for thallium is attributable to the laboratory detection limit. 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, Colby Lake, or the Lower Partridge River 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 4.1-74 indicates, the Mine Site Alternative would result in improved water quality for most parameters, although chloride, lead, selenium, sulfate, and zinc concentrations are predicted to be marginally lower under the Proposed Action.[60]

Table 4.1-74 Comparison of Predicted Maximum Concentrations for the Upper Partridge River under the Proposed Action and Mine Site Alternative

General Parameter	Unit	Standard	Proposed Action Max Concentration	Mine Site Alternative Max Concentration
Chloride	mg/L	230	8.2	9.9
Fluoride	mg/L	--	0.3	0.3
Hardness	mg/L	500	119	114
Sulfate	mg/L	--	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	2.5(1)	0.1	0.1
Cobalt	µg/L	5.0	2.1	1.6
Copper	µg/L	9.3(1)	7.0	3.4
Iron	µg/L	--	2,349	2,348
Lead	µg/L	3.2(1)	1.1	1.2
Manganese	µg/L	--	150	150
Nickel	µg/L	52(1)	25.6	15.2
Selenium	µg/L	5.0	1.8	2.0
Thallium	µg/L	0.56	0.4	0.4
Vanadium	µg/L	--	9.0	7.0
Zinc	µg/L	120(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 100 mg/L.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

60 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 4.1-74).

West Pit Overflow Water Quality Predictions

Around Year 65, the West Pit is predicted to overflow. The deterministic modeling results suggest that perhaps as many as three parameters could exceed water quality standards for this alternative, in addition to relatively high sulfate concentrations. The data in Table 4.1-75 reflects the highest predicted concentrations from all flow conditions.

In comparison with the Proposed Action, the Mine Site Alternative would have 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 cobalt, copper, and nickel concentrations may be higher than predicted by the deterministic model. PolyMet states that these exceedances are the result of applying the constant solute production method instead of the exponential decay method for predicting solute loading from the pit wall (applies to cobalt and nickel) and excluding the effects of adsorption (applies to copper).

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 deterministic modeling results suggest that three parameters (i.e., arsenic, cobalt, and selenium) could exceed surface water quality standards, in addition to relatively high sulfate concentrations. The Uncertainty Analysis for the Proposed Action suggests that copper and nickel could be underestimated by the deterministic modeling, which may also apply to the deterministic modeling for the Mine Site Alternative as well. The unnamed tributary to which the West Pit would discharge would essentially function as a mixing zone (Figure 4.1-22), but water quality standards may be exceeded. There is the potential that this overflow could result in a short reach (approximately 1,000 feet) of the Upper Partridge River between the confluence with the unnamed tributary and the South Branch Partridge River exceeding some surface water standards. 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-004a (located approximately 1,000 feet downstream from where the West Pit overflow would reach the Partridge River) or Colby Lake based on deterministic modeling. These exceedances also reflect the effects of an initial release of solutes from the flooding of the pit walls, which is expected to be a relatively short term effect. Water quality in the West Pit is expected to improve over time as oxidation would be negligible once the pit walls are submerged. The pit walls are predicted to be the primary source of the potential cobalt, copper, and nickel exceedances and a major source of the potential arsenic exceedance. Section 4.1.3.5 discusses potential mitigation measures that address the potential for exceedances of surface water standards in the West Pit overflow.[61]

Table 4.1-75 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	18.6	18.6
Antimony	ug/L	31	22.2(2)	28.2(2)
Arsenic	ug/L	53	**188**	**198**
Cadmium	ug/L	7.3(1)	0.23	0.15
Cobalt	ug/L	5.0	**6.9**	**8.0**
Copper	ug/L	30.0(1)	6.0	6.0
Iron	ug/L	--	100	100
Lead	ug/L	19.0(1)	7.8	6.5
Manganese	ug/L	--	10	10
Nickel	ug/L	169(1)	61	71.5
Selenium	ug/L	5.0	**14.8**	**7.7**
Thallium	ug/L	0.56	0.19	0.26
Vanadium	ug/L	--	74.8	77.8
Zinc	ug/L	388(1)	52	48.6

Source: Table 4-58, 4-59, and 4-60, RS74A, Barr 2008. Hinck, Pint, and Wong, Revised Model Results for Antimony at the Mine Site, July 22, 2009.

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 400 mg/L.

2 The predicted antimony concentration was revised subsequent to the issuance of RS74A because the dissolution rate originally used was based on the NorthMet humidity cells, which were contaminated for antimony, rather than the MnDNR reactor data. See Hinck, Pint, and Wong; *Revised Model Results for Antimony at the Mine Site*, September 25, 2009.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[61] 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.

Waters That Contain Wild Rice

The estimated effects of the Mine Site Alternative on each of the identified wild rice areas (Figure 4.1-15) is summarized in Table 4.1-76 and discussed below. The Mine Site Alternative would have no effect on the hydrology or water quality of the Embarrass River and, therefore, would not be expected to have any effects on wild rice along the Embarrass River as compared to the Proposed Action.

Table 4.1-76 Estimated Effects of the Mine Site Alternative on Wild Rice Areas

Wild Rice Areas	Density Factor	Measured (M) and Average (A) Sulfate Concentration	Water Quality Effect Predicted/Estimated Sulfate Concentration – Average Flow[2]	Hydrologic Effect
Upper Partridge River	1	5-6 mg/L	10 -16 mg/L (at SW-005)	Reduce critical annual 7-day low flow by only 0.14 cfs at SW-005 (Table 4.1-57)
Lower Partridge River	3-5	47-289 mg/L	Estimate of 1 to 2 mg/L increase due to dilution, deposition, and biological uptake	Reduce average flow from Colby Lake by 10.5 cfs (9%)

1 "Measured" sulfate concentration was measured during the wild rice field survey.
2 Predicted sulfate concentrations used in this analysis represent average flow conditions, so sulfate concentrations presented here will vary from concentrations presented elsewhere in this DEIS where low flow conditions are referenced.

In the Upper Partridge River, the Proposed Action would have little hydrologic effect on wild rice in terms of changes in flows or water levels relative to existing conditions. In the Lower Partridge River, average flows would be decreased by up to 10.5 cfs during Project operations. This hydrologic impact may be offset to some extent by increased discharges from the proposed Mesabi Nugget Phase II Project (see Section 4.1.4 – Cumulative Effects on Water Resources). The Proposed Action would increase, however, sulfate concentrations in the Partridge River via groundwater seepage from the waste rocks stockpiles and pit lakes and eventually (approximately Year 65) the West Pit overflow. Sulfate concentrations are predicted to increase in the Upper Partridge River from approximately 9 mg/L to about 16 mg/L under average flow conditions. In the Lower Partridge River, the predicted sulfate concentrations in water flowing from Colby Lake (approximately 14 mg/L) would have little effect on the elevated sulfate concentrations (average of 149 mg/L) found in the Partridge River downstream of Second Creek.

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, concerns exist 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 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 remains some uncertainty as to whether the West Pit overflow would meet the Great Lakes Initiative standard for mercury and additional analysis of this issue is recommended.[62] Section 4.1.3.5 discusses potential mitigation measures that address potential exceedances of mercury concentrations in the West Pit overflow.

Summary of the Mine Site Alternative

Table 4.1-77 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 4.1-77 Water Resource Impact Summary of the Mine Site Alternative

Key Potential Issues	Effects of the Mine Site Alternative	Reference Page Number
Groundwater levels at the Mine Site	Drawdown expected during mine operations and filling of West Pit (~65 years).	Same as Proposed Action
Groundwater quality at the Mine Site	Antimony concentrations predicted to exceed groundwater evaluation criteria, but may not when use of concentration cap from contaminated humidity cells is accounted for.	4.1-136
Flows in the Upper Partridge River	Reduce average flow by approximately 1.5 cfs. Minimal reduction in annual 7-day low (~0.1 cfs). No significant effect on river morphology or 100-year floodplain.[63]	Same as Proposed Action
Water quality in the Upper Partridge River	All parameters predicted to meet surface water quality standards during all flow conditions for all mine years. West Pit overflow in Closure predicted to initially exceed standards for several parameters, but water quality is expected to improve over time and exceedances could be mitigated.[64]	4.1-141
Water levels in Colby Lake and Whitewater Reservoir	Negligible increase (0.3 ft) in average water level drawdown and improvement in maximum annual fluctuation and % days below critical elevation at Colby Lake. Water level fluctuations and average drawdown would increase at Whitewater Reservoir relative to existing conditions, but would be no greater than when LTVSMC was operating.	Same as Proposed Action

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[62] As previously discussed, it is the tribal cooperating agencies' position that this analysis must be included in the DEIS.
[63] Tribal cooperating agencies take the position that there is insufficient data to support this claim.
[64] Tribal cooperating agencies take the position that the west pit is predicted to exceed standards for all years for which predictions were made.

Key Potential Issues	Effects of the Mine Site Alternative	Reference Page Number
Water quality in Colby Lake & Whitewater Reservoir	All parameters predicted to meet all water quality standards during all flow conditions for all mine years.	4.1-141
Flows in the Lower Partridge River	Reduce average flows by as much as 10.5 cfs (9%) and increase the frequency of low flows.	Same as Proposed Action
Water Quality in the Lower Partridge River	All parameters predicted to meet surface water quality standards during all flow conditions for all mine years.[65]	4.1-141
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
Waters That Contain Wild Rice	Increase in hydrologic variability and about a 1 to 2 mg/L increase in sulfate concentrations in the Lower Partridge River, although sulfate concentrations are already elevated in this area (>100 mg/L). No effect on the hydrology or water quality of the Embarrass River.	4.1-145
Mercury in Water	There is some uncertainty as to whether the West Pit overflow would meet the Lake Superior mercury standard, but this impact could be mitigated if it would occur.	4.1-145

4.1.3.4 Tailings Basin Alternative

The intent of the Tailings Basin Alternative is to reduce metal concentrations in groundwater downgradient from the Tailings Basin; to avoid the release of groundwater 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 to improve the geotechnical stability of the tailings basin. These objectives would be achieved by installing vertical wells near the outside toe of the tailings embankment that would capture approximately 95% of the groundwater seepage (and presumably about 95% of the pollutant load from the NorthMet Tailings assuming uniform distribution in 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) (Figure 3.2-2); and

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[65] Tribal cooperating agencies take the position that the wild rice standard for sulfate would be exceeded.

- Extend bentonite amended tailings cover over the top of the entire uppermost lift of the embankment.

The Tailings Basin Alternative also includes provisions for a Passive Reactive Barrier demonstration test and for seepage water treatment prior to discharge to the Partridge River. Neither of these provisions was included in the water quality modeling that was conducted. If determined to be necessary based on actual seepage water quality, the treatment plant would be required.

Two different options are considered under this alternative, which relate to the extent of recycling groundwater 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 most withdrawals from Colby Lake, and pump the remaining seepage to the Partridge River. The "No Recycle Option" would not return any groundwater seepage collected by the vertical wells to the Tailings Basin and would pump all groundwater 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 groundwater 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 groundwater 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.[66]

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 groundwater seepage rates and water quality would determine when pumping could be terminated and the groundwater seepage allowed to flow naturally toward the Embarrass River. A permeable reactive barrier (PRB) would be installed to provide final treatment of the groundwater seepage, if needed, to meet groundwater evaluation criteria, assuming testing during operations demonstrates it to be effective.[67]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[66] 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.

[67] 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.

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 groundwater seepage rates above the flux capacity of the aquifer, resulting in upwelling of groundwater 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 western side of 2W (Figure 3.2-2) would collect most of the NorthMet groundwater seepage via pumping, with discharge either back into the Tailings Basin for reuse at the Plant Site and/or discharge to the Partridge River. Table 4.1-78 summarizes groundwater seepage generation and the estimated 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 NorthMet groundwater seepage being released to the aquifer downgradient of the Tailings Basin by approximately 95% during operations and Closure (until pumping ceases) as compared with the Proposed Action. The rate of unrecovered NorthMet groundwater seepage would be less than the aquifer flux capacity (i.e., 155 gpm), but the total groundwater seepage rate (NorthMet seepage plus residual LTVSMC seepage from Cell 2W) would still significantly exceed aquifer flux capacity during operations and would approximately quadruple the 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 groundwater 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 4.1-78 Tailings Basin Groundwater Seepage Toward the Embarrass River for the Tailings Basin Alternative (in gpm)

	NorthMet Groundwater Seepage						Total Groundwater Seepage					
Mine Year	**Cell 1E/2E Seepage**	**Hydromet Leakage**	**Total Seepage**	**Total Unrecovered Seepage**	**Total Recovered Seepage[2]**	**% Recovered Seepage**	**Total NorthMet Seepage**	**Cell 2W Seepage**	**Total Seepage**	**Total Unrecovered Seepage**	**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	975	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	25	466	95%	491	610	1,101	635	466	42%

Source: Hinck 2009.

1 Existing Cell 1E/2E seepage is a legacy from LTVSMC operations and not attributable to NorthMet.

2 The seepage collection system would collect an additional average of approximately 100 gpm of surface seepage during mine operations that is not included in the values presented in this table.

3 Surface water quality impacts for the Embarrass River (Hinck 2009) assumed 780 gpm of Cell 1E/2E groundwater 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 4.1-79 provides the predicted seepage water quality as it leaves the Tailings Basin, not accounting for any dispersion, dilution, or sorption. The toe of the Tailings Basin is not considered an evaluation point in terms of comparison with groundwater evaluation criteria. The predicted solute concentrations for the Maximum Recycle Option are, with the exceptions of iron and thallium, higher than for the No Recycle Option, and would generally be higher 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. The solute concentrations for the No Recycle Option would be similar to the Proposed Action.

It should be noted that the predicted seepage concentrations in Table 4.1-79 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 4.1-79 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	107	68	108	54	112	54
Chloride	mg/L	17	3.9	17	3.2	20	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	11	21	11	19	12	19
Sodium	mg/L	64	26	64	20	70	20
Sulfate	mg/L	241	174	241	145	262	145
Metals – Total							
Aluminum	ug/L	176	78	176	77	180	77
Antimony	ug/L	11	1.2	11	1.1	12	1.1
Arsenic	ug/L	12	28	12	24	13	24
Barium	ug/L	36	19	36	16	43	16
Beryllium	ug/L	0.7	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	12	12	12
Iron	ug/L	569	98	569	87	325	87
Lead	ug/L	3.4	1.0	3.4	0.8	3.4	0.8
Manganese	ug/L	97	140	97	109	173	109
Nickel	ug/L	25	6	25	4.6	34	4.6
Selenium	ug/L	1.7	3.3	1.7	2.7	1.8	2.7
Silver	ug/L	0.6	1.2	0.6	1.0	0.7	1.0
Thallium	ug/L	0.8	0.1	0.8	0.1	0.7	0.1
Zinc	ug/L	79	13	79	12	90	12

Source: Tables 1, 2, and 4, Barr 2009, Technical Memorandum: Tailings Basin Seepage Quality Predictions, June 24, 2009

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 remaining 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, the low end of the USEPA screening level values are used, 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.

Tables 4.1-80 and 4.1-81 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. The predicted aluminum concentrations would exceed the lower end, but not the upper end, of the USEPA secondary MCL range, 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. The predicted levels of aluminum would be within the range of ambient concentrations found in nearby wells (Table 4.1-8).

Table 4.1-80 Summary of Maximum Concentrations Predicted Using Transient Flow Modeling for the Tailings Basin Alternative – No Recycle Option

			Predicted Maximum Concentration				
Solute	**Unit**	**Groundwater Evaluation Criteria**	**Property Boundary Location**	**Residential Well Evaluation Location**	**Embarrass River Evaluation Location[2]**	**Period Exceeding Groundwater Criteria (Mine Years)**	**Predicted Maximum Concentration (no sorption) Prop boundary**
Aluminum	µg/L	50 - 200	**100**	**80**	49	~60 to >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	**17**
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	300	192	193	193	NA	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: Values in **bold** exceed groundwater evaluation criteria
1 Predicted arsenic concentrations were modeled assuming a sorption Kd of 25.
2 The Embarrass River Groundwater evaluation point reflects groundwater quality directly upgradient from the Embarrass River and does not include water flowing in the river, which is subject to surface water standards (Figure 4.1-26).

Table 4.1-81 Summary of Maximum Concentrations Predicted Using Transient Flow Modeling for the Tailings Basin Alternative – Maximum Recycle Option

			Predicted Maximum Concentration (with sorption)				
Solute	**Unit**	**Groundwater Evaluation Criteria**	**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 to >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	300	192	193	193	NA	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: Values in **bold** 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 groundwater seepage captured by the vertical wells to the Partridge River, downstream of Colby Lake, but upstream of Second Creek. This discharge, which varies in volume and slightly in quality between the No Recycle and Maximum Recycle options, would affect flows and water quality in the Lower Partridge River, but would have no effect on flows or water quality in the Upper Partridge River.[68]

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 (1.8 cfs) (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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

68 Tribal cooperating agencies take the position that discharging untreated tailings basin water to the Partridge River will have significant adverse impacts.

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 surface 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 groundwater seepage captured by the vertical wells to the Partridge River (both options). As Table 4.1-82 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 4.1-82 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	-1.2 cfs	-7.8 cfs	0 cfs	-10.5 cfs
Tailings Basin Alternative No Recycle Option	-1.5 cfs	-1.2 cfs	-7.8 cfs	+5.2 cfs	-5.3 cfs
Tailings Basin Alternative Maximum Recycle Option	-1.5 cfs	-1.2 cfs	-1.8 cfs	+1.1 cfs	-3.4 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 Action*s); therefore, the net reduction in Partridge River flow from the two Tailings Basin Alternative options would represent a small percentage of average flow (3 to 4%). Under low flow conditions, the MnDNR Water Appropriation 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 relative to the Proposed Action, 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 of Tailings Basin seepage to the Lower Partridge River, immediately downstream of the Colby Lake outlet, over the approximately 20-year life of the mine. Table 4.1-79 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 parameter predicted to exceed surface water standards would be thallium.[69] 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.

The water quality predictions imply that aluminum may exceed the surface water quality standard. The surface water standard of 125 µg/L, however, represents dissolved aluminum concentrations, while the predicted concentration represents total aluminum concentrations.[70] The available water quality monitoring data for the toe of the Tailings Basin (Table 4.1-7) indicate that the dissolved aluminum concentrations in at least the LTVSMC seepage is quite low (<25 µg/L) and well below the surface water standard. Further, the Partridge River receiving water has relatively neutral pH, under which conditions aluminum is not normally very soluble. Therefore, the discharge of seepage from the vertical wells to the Partridge River is expected to meet the surface water standard for dissolved aluminum.

Therefore, the Tailings Basin Alternative is not predicted to result in the exceedance of any surface water quality standards in the Lower Partridge River.[71] The Tailings Basin Alternative would, however, 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 4.1-83 shows, sulfate concentration would increase in the Lower 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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[69] 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.

[70] 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.

[71] 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.

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. This increase in sulfate concentrations would affect the reach of the Partridge River between the discharge point downstream of Colby Lake to the confluence with Second Creek, where average sulfate concentrations are already much higher than those predicted for the Tailings Basin Alternative. In general, a similar pattern is expected for other parameters. The cumulative effects of the Project, in combination with other sources of sulfate in the Lower Partridge River and further downstream in the St. Louis River are discussed in Section 4.1.4.

Table 4.1-83 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 Downstream of Colby Lake	Not available	30.4	Not available
Tailings Basin Alternative No Recycle Option Downstream of Colby Lake[1]	80.8[(2)]	39.6	Not available
Tailings Basin Alternative Maximum Recycle Option Downstream of Colby Lake[1]	58.3[(2)]	35.1	Not available
Existing Condition Downstream of Second Creek	Not available	149[(1)]	Not available

Source: Hinck and Wong, Additional information in support of *NorthMet DEIS Critical Path Required Action - TB-11: Revised cumulative effects analysis to include Tailings Basin Alternative*, September 11, 2009.
1 Monitoring location is downstream of the Colby Lake outlet at Mesabi Nugget's MNSW14 monitoring station.
2 From Mesabi Nugget stream monitoring, email from Miguel Wong, Barr, to David Blaha, ERM, dated July 20, 2009.

Effects on the Embarrass River

The Tailings Basin Alternative would capture most of the Tailings Basin groundwater seepage and discharge it to the Partridge River downstream of Colby Lake and upstream of Second Creek. This discharge would reduce groundwater contribution to flow and affect water quality in the Embarrass River.

Flow in the Embarrass River

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 groundwater seepage recovered by the vertical wells would be the same under each option. Table 4.1-78 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 groundwater 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) relative to existing conditions. During Closure (at least until seepage water quality would be of good enough quality to allow pumping by the vertical wells to cease), NorthMet groundwater 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 85.5 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 9.7 cfs). To the extent that much of this groundwater seepage is expected to upwell to the surface because it would exceed the groundwater flux capacity of the aquifer, these reductions in groundwater seepage would not directly translate to reductions in the baseflow (groundwater) contribution to the Embarrass River.

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 its potential relationship with mercury methylation. Under both Tailings Basin Alternative options, most of the Tailings Basin groundwater 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 modeling 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 4.1-84 provides the maximum predicted concentrations for the parameters evaluated under both the No Recycle and Maximum Recycle options. The data indicate 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 Alternative options, with concentrations for several parameters slightly higher under the Maximum Recycle Option. For both options, all parameters are expected to meet surface water standards during all flow conditions for all modeled years.[72]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[72] 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 4.1-84 Predicted Water Quality along the Embarrass River (PM-13) for the Tailings Basin Alternative

Parameter	Units	Standard	Existing Modeled Conditions[3]	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	--	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[(4)]	427[(4)]	Low Flow	427[(4)]	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	5.1[(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	20.7[(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	264[(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*

Note: Values in **bold** exceed applicable surface water standards. In this case, no exceedances were predicted.

1 The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

2 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 255 mg/L.

3 "Existing Modeled Conditions" reflect predicted existing concentrations for the various parameters under the applicable low condition based on available water quality monitoring and estimates of pollutant loads by source. Average existing water quality concentrations are presented in Table 4.1-29.

4 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

As discussed above, the surface water standard of 125 µg/L represents dissolved aluminum, while the predicted concentration represents total aluminum.[73] The available water quality monitoring data (Table 4.1-8) indicate that the dissolved aluminum concentrations in at least the LTVSMC seepage is quite low (<25 µg/L) and well below the surface water standard. Further, the Embarrass River has relatively neutral pH, under which conditions aluminum is not normally very soluble. Therefore, the aluminum concentration in the Embarrass River would be expected to meet the surface water standard for dissolved aluminum.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

73 It is the tribal cooperating agencies' position that the results in TB-15 represent dissolved aluminum. TB-15 predicts exceedance of the aluminum standard.

Under the Tailings Basin Alternative, the capture of Tailings Basin groundwater seepage by the vertical wells would reduce the sulfate loading to the Embarrass River under all flow conditions (i.e., low, average, and high flows from the XP-SWMM model), which would slightly reduce sulfate concentrations in the Embarrass River under average and high flow conditions relative to existing conditions (Table 4.1-85). Under low flow conditions, the sulfate loading would still be reduced, but this effect would be offset by reduced flows in the Embarrass River from the seepage capture resulting in slightly higher sulfate concentrations (Barr 2009, *Additional information in support of NorthMet DEIS Critical Path Requires Actions*).[74] Table 4.1-85 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.

Table 4.1-85 Comparison of Predicted Sulfate Concentrations for the Embarrass River at PM-13

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

Source: Wenigmann and Wong, *TB-15 Surface Water Quality Model and Results for Tailings Basin - Proposed Action and Tailings Basin Alternative,* June 24, 2009.

Waters That Contain Wild Rice

The estimated effects of the Proposed Action on each of the wild rice areas (Figure 4.1-15) is summarized in Table 4.1-86 and discussed below.

In the Upper Partridge River, the Tailings Basin Alternative would have little hydrologic effect on wild rice in terms of changes in flows or water levels relative to existing conditions. In the Lower Partridge River, average flows would be decreased by up to 5% during Project operations. This hydrologic impact may be offset to some extent by increased discharges from the proposed Mesabi Nugget Phase II Project (see Section 4.1.4 – Cumulative Effects on Water Resources). The Tailings Basin Alternative would increase, however, sulfate concentrations in the Partridge River via groundwater seepage from the waste rocks stockpiles and pit lakes and eventually (approximately Year 65) the West Pit overflow. Sulfate concentrations are predicted to increase in the Upper Partridge River from approximately 5 to 6 mg/L as measured during the wild rice field study, (historic average of about 9 mg/L) to about 14 mg/L under average flow conditions.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[74] The tribal cooperating agency position is clear. The wild rice standard applies and must be enforced.

Table 4.1-86 Estimated Effects of the Tailings Basin Alternative on Wild Rice Areas

Wild Rice Areas	Density Factor	Measured Sulfate Concentration[1]	Water Quality Effect Predicted/Estimated Sulfate Concentration Average Flow[2]	Hydrologic Effect
Partridge Watershed				
Upper Partridge River	1	5-6 mg/L	10 -14 mg/L (at SW-005)	Reduce critical annual 7-day low flow by only 0.14 cfs at SW-005 (Table 4.1-54)
Lower Partridge River	3-5	47-289 mg/L	Estimate of 1 to 9 mg/L increase @ MNSW14 due to dilution.	Reduce average flow in Lower Partridge River by 3.4 to 5.3 cfs (3-5%)
Embarrass Watershed				
Embarrass River	1	33 mg/L	35 mg/L (at PM-13)	Reduce average flow by 1.7 to 1.9 cfs – seepage rate would be relatively constant over a single growing season so negligible effect on water levels
Hay Lake	1	2 mg/L	No effect – tributary to Embarrass River	No effect Tributary to Embarrass River
Sabin Lake	1	Not Available – Estimated as 29 mg/L	30 mg/L due to dilution, deposition, and biological uptake	Negligible effect Lake would attenuate any water level fluctuations
Wynne Lake	1	Not Available - Estimated as 25 mg/L	No change	Negligible effect Upstream lakes would attenuate any water level fluctuations
Embarrass Lake	1	21 mg/L	No change	Negligible effect Upstream lakes would attenuate any water level fluctuations
Lower Embarrass Lake	1	21 mg/L	No change	Negligible effect Upstream lakes would attenuate any water level fluctuations
Unnamed Lake	1	21 mg/L	No change	Negligible effect Upstream lakes would attenuate any water level fluctuations
Cedar Island Lake	1-5	20 mg/L	No change	Negligible effect Upstream lakes would attenuate any water level fluctuations
Esquagama Lake Outlet	1	17 mg/L	No change	Negligible effect Upstream lakes would attenuate any water level fluctuations

1 "Measured" sulfate concentration was measured during the wild rice field survey.
2 Predicted sulfate concentrations used in this analysis represent average flow conditions, so sulfate concentrations presented here will vary from concentrations presented elsewhere in this DEIS where low flow conditions are referenced.

In the Lower Partridge River, the predicted sulfate concentrations resulting from both groundwater seepage and the discharge of captured Tailings Basin seepage would increase sulfate concentrations downstream of the Colby Lake outlet from 30.4 to 39.6 mg/L during operations under average flow conditions, but would only increase the sulfate concentrations (average of 149 mg/L) found in the Partridge River downstream of Second Creek to a maximum of about 152 mg/L.

In the Embarrass River, the Tailings Basin Alternative would have little hydrologic effect on wild rice in terms of changes in flows or water levels relative to existing conditions. The reduced seepage from the Tailings Basin would still be relatively constant over a single growing season and should have little if any effect on wild rice. Existing sulfate concentrations are already elevated in the Embarrass River (i.e., average flow sulfate concentrations at PM-13 is 36 mg/L) because of overflow from Pit 5NW (average sulfate concentration of 1,046 mg/L) and seepage from the LTVSMC Tailings Basin (average sulfate concentration of approximately 155 mg/L – Table 4.1-7). The Tailings Basin Alternative would slightly decrease sulfate concentrations under average flow conditions at PM-13 because of reduce sulfate loading. Therefore, the Tailings Basin Alternative should have little effect on sulfate concentrations in wild rice areas downstream on the Embarrass River.

Mercury in Water

The primary way the Tailings Basin Alternative differs from the Proposed Action in terms of mercury in the Embarrass River watershed is related to the potential for sulfate to promote mercury methylation. As discussed previously, additional sulfate can promote (i.e., elevate above baseline conditions) mercury methylation in certain high risk situations, such as wetlands and lakes that stratify, when sulfate is limiting.

Under the Tailings Basin Alternative, the peak annual sulfate loading (Year 10) attributable to the Project (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% from the Proposed Action (Table 4.1-87) and would actually be over 70% less than existing conditions. Therefore, the Tailings Basin Alternative would reduce the sulfate loadings to the wetlands north of the Tailings Basin and to the downstream chain of lakes along the Embarrass River that are considered high risk situations by MPCA.

Table 4.1-87 Maximum Annual NorthMet Sulfate Loading from Cells 1E/2E

Alternative	Unrecovered Seepage Rate (gpm)	Concentration (mg/L)	Annual Sulfate Loading (kg/year)
Existing Conditions	900	152	272,000
Proposed Action (Year 10)	2,490	212	1,050,000
Tailings Basin Alternative No Recycle Option (Year 15)	135	171	46,000
Tailings Basin Alternative Max Recycle Option (Year 20)	145	233	67,000

Source: Barr, 2009, Tailings Basin Culpability Analysis.

It is unclear what effect this reduction in sulfate loadings would have on mercury methylation. Existing data do not show elevated methylmercury concentrations downstream of the Tailings Basin relative to an upstream control location unaffected by mining. PolyMet is conducting additional monitoring that should provide better data to determine the effect of sulfate on methylmercury concentrations north of the Tailings Basin.

Summary of the Tailings Basin Alternative

Table 4.1-88 provides a summary of the primary water resource effects of the Tailings Basin Alternative. Under this alternative, the capture of Tailings Basin groundwater 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 (about 95%) 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 load, would be directed away from the wetlands and downstream lakes on the Embarrass River, resulting in a reduction in the risk of mercury methylation. The discharge of captured seepage to the Partridge River is predicted to meet surface water standards.[75]

Table 4.1-88 Water Resource Impact Summary of the Tailings Basin Alternative

Key Potential Issues	Effects of the Tailings Basin Alternative	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 and Whitewater Reservoir	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 relative to the Proposed Action.	4.1-153
Water quality in Colby Lake & Whitewater Reservoir	Not applicable	Not applicable
Flows in the Lower Partridge River	Reduce average flow by between 3.4 cfs (Max Recycle Option) and 5.3 cfs (No Recycle Option), but should have negligible effect on river morphology.	4.1-154
Water quality in the Lower Partridge River	Discharge of between 1.1 cfs (Maximum Recycle Option) and 5.2 cfs (No Recycle Option) of groundwater seepage pumped from vertical wells to the Lower Partridge River would meet all surface water quality standards during all flow conditions for all mine years, although it would significantly increase sulfate loadings and reduce the available assimilative capacity.[76]	4.1-155

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[75] 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.

[76] 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.

Key Potential Issues	Effects of the Tailings Basin Alternative	Reference Page Number
Groundwater levels downgradient of the Tailings Basin	Pumping by vertical wells would reduce the amount of unrecovered NorthMet groundwater seepage by approximately 95% during operations and closure (until pumping is allowed to cease) relative to existing conditions.	4.1-149
Groundwater quality downgradient of the Tailings Basin	Groundwater seepage from the Tailings Basin is predicted to meet all groundwater evaluation criteria with the possible exception of aluminum. Aluminum is a USEPA secondary MCL standard for managing aesthetic consideration and not to protect human health, and is naturally found in elevated concentrations in the Project area.[77]	4.1-149
Flows in the Embarrass River	Average flow reduced by 1.7 cfs (during operations) and 1.9 cfs (during Closure), but should have negligible effect on river morphology.	4.1-156
Water quality in the Embarrass River	All parameters predicted to meet all surface water quality standards in the Embarrass River under all flow conditions for all mine years.[78]	4.1-157
Waters That Contain Wild Rice	No effect on hydrology or water quality of the Upper Partridge River relative to the Proposed Action. Reduction in water level fluctuations in the Lower Partridge River, but 1 to 9 mg/L increase in sulfate concentrations, although sulfate concentrations are already elevated in this area (>100 mg/L). Negligible effect on seasonal hydrology and negligible effect on average sulfate concentrations (<1 mg/L) in the Embarrass River.	4.1-159
Mercury in Water	70% reduction (relative to existing conditions) in NorthMet sulfate loading from Cells 1E/2E to high risk mercury methylation environments (i.e., wetlands and downstream lakes).	4.1-161

4.1.3.5 Mitigation and Monitoring 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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[77] 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.”

[78] 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.

Potential Mitigation Measures

Potential mitigation measures at the Mine Site, Plant Site, and Tailings Basin are discussed below.[79]

Mine Site

- Waste Rock Stockpile Liner Leakage – PolyMet proposes various stockpile liner and cover systems that are related to the degree of waste rock reactivity. All liners leak to some extent and the modeling considered low, average, and high rates of liner leakage. It was concluded that the high liner leakage rate, which reflects a combined worst case scenario, probably overestimates liner leakage. Concerns were also raised regarding the extent to which the low and average liner leakage rates reflect the uncertainty associated with the essentially permanent nature of these stockpiles under the Proposed Action. If needed, enhanced liner and cover system design and analysis of long-term uncertainty should be able to demonstrate the feasibility of acceptable permanent surface waste rock storage facilities, but in this case, the option to provide subaqueous disposal of waste rock is available and preferred to surface storage, so mitigation measures to address surface storage are not further considered in this DEIS.

- Overliner Buffer Thickness – PolyMet proposes to protect the liner with an overliner buffer of 12 to 18 inches of soil. In general, overliner buffer thickness should be approximately half the diameter of the largest rock placed on the liner, so if the stockpiled rock would have a maximum diameter of about six feet, then the overliner buffer should be about three feet. The proposed overliner buffer may not be adequate to protect the geomembrane from accidental tears and rips during waste rock placement or removal (under the Mine Site Alternative) given both the size of the waste rock and the equipment necessary to place or remove it. Further, the overliner buffer is also used to drain liner yield to the stockpile sumps. The non-ferrous rules (*Minnesota Rules*, part 6132.2200) state that substantially all water should be prevented from moving through or over waste rock. A thicker overliner system may be necessary to meet the requirements of this rule. A nominal overliner thickness of 24 to 36 inches is recommended.

- Chemical Modification of the Category 3 and 4 waste rock and Category 3 lean ore stockpiles - PolyMet currently proposes to construct permanent waste rock stockpiles, which

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[79] 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.

would be capped and revegetated as part of mine closure. Although capping and 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 during mine operations prior to reclamation. 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. This mitigation method is proposed as part of the Mine Site Alternative.

- Enhanced Category 1 stockpile liner – The Category 1 stockpile is the source of among the highest, if not the highest, antimony and sulfate concentrations in groundwater at the Mine Site under both the Proposed Action and Mine Site Alternative. Depending on the adequacy of the overburden field characterization method that is developed (see discussion below), there is the potential that more reactive overburden could be placed in the Category 1 stockpile as well. PolyMet currently proposes a 12-inch compacted soil liner for this stockpile. An enhanced (i.e., lower permeability) liner may be warranted depending on final groundwater quality predictions.

- Overburden Management - PolyMet indicates it would segregate overburden and place the saturated overburden in the Category 1 and 2 waste rock stockpile. Preliminary sample analysis of overburden materials indicates that the saturated overburden has sufficient sulfur content (in some cases equivalent to Category 4 waste rock) to acidify and release elevated concentrations of various metals and sulfate. There is concern that placement of this material in the Category 1 and 2 waste rock stockpile could result in acidification and release of various metals and sulfate on a liner system that was not designed for this level of reactivity.

  A key element to overburden management is to develop a workable field characterization method to determine the level of reactivity of the overburden being excavated. Once this information is known, there are several potential mitigation measures that could avoid or minimize these impacts, including:

  - Maximize the use of reactive overburden in appropriate temporary and permanent storage facilities. For example, suitable reactive overburden could be used as foundation or buffer material beneath stockpile geomembrane liners or as subaqueous cover over the waste rock placed in the East Pit prior to constructing the proposed treatment wetlands where it would remain in submerged/saturated conditions.

  - Place the remaining reactive overburden in the appropriate location for its level of reactivity in terms of both temporary storage (e.g., overburden with reactivity comparable to Category 3 waste rock would be placed in the Category 3 waste rock stockpile) and permanent disposal (e.g., possible subaqueous disposal of the more reactive overburden material in the East Pit).

  - Depending on the ultimate use for the material, additional processing and screening would be needed to produce the correct size and hydraulic conductivity for the various covers and liners. Low reactivity rock screened from the material could be used for other out-of-pit construction activities, such as road construction, reclamation activities, and possibly even embankment material at the Tailings Basin in lieu of using LTVSMC coarse tailings. Additional testing and operational characterization may be required for the use of overburden for these purposes.

- 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 collected and treated at the WWTF.

- Increase Backfill of the East Pit – Mining would expose portions of the high sulfide Virginia Formation in the East Pit. PolyMet proposes to place overburden and a low permeability cover against the exposed Virginia Formation high wall 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 this technology has not been demonstrated.

  Alternatively, the East Pit could be filled such that a geomembrane cover could be installed on a relatively flat surface over the entire exposed Virginia Formation area. In order to avoid long term cover maintenance, non-reactive overburden could be used to form a mound over the area so that woody species removal would not be necessary. This potential mitigation measure would reduce the size of the treatment wetland proposed for the East Pit in Closure.

- Expedite Flooding of the West Pit – oxidation of the West Pit wall rock is predicted to be a significant source of loadings for various constituents in the ultimate pit lake water quality. Expedited flooding of the West Pit could reduce chemical contributions from the pit wall as it would be flooded more quickly, thereby potentially reducing the extent of oxidation. The likely source of water to expedite flooding of the West Pit would be Colby Lake. Since flooding of the West Pit would not begin until mining operations cease in Year 20, there would be no make up water withdrawals during Closure and this water could not be available to expedite flooding of the West Pit. A preliminary analysis indicated that flooding the West Pit in about 13 years rather than about 45 years, as currently proposed, could reduce mean concentrations of the eight constituents evaluated in the Uncertainty Analysis by 60 to 72% (Hinck, *Additional Information on Expedited Flooding of the West Pit*, July 15, 2009). However, Colby Lake has elevated concentrations of mercury that could make it more difficult for the West Pit overflow to meet the Lake Superior surface water standard for mercury (1.3 ng/L). This potential mitigation warrants further consideration.

- 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, at least initially, 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). This treatment method should also be effective in removing selenium, which is sensitive to changes in redox conditions.

- Provision of a mercury filter – establishment of a mercury filter similar to that proposed at the Mesabi Nugget Phase I Project could possibly be used to reduce mercury concentrations to below the 1.3 ng/L standard. This filter, which uses taconite tailings, has reduced mercury from an influent concentration of 2.8 ng/L to an average effluent concentration of 0.65 ng/L based on pilot testing (Mesabi Nugget 2005).

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 (RS52, Barr 2007). Concerns exist 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 and sulfate concentrations in the influent.

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. Treatment at the WWTF (if needed at all) is not expected to be required long-term as pit wall oxidation would be negligible once the West Pit is completely flooded, thereby significantly reducing solute loadings to the pit lake. It is recommended 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. It is recommended that 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 to 24 million cubic yards of LTVSMC coarse tailings as embankment fill material. A culpability analysis (Wenigmann, Pint, and Wong 2009) indicates that these LTVSMC tailings represent a significant source of solute loading to the NorthMet Tailings Basin seepage during Closure (approximately 65% of the sulfate and 50% of the arsenic loadings).

  It is recommended 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 Tailings Basin (Arends 2009). The evaluation resulted in 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 and whether the material would be available for use. Potential air quality effects associated with hauling the material must be balanced against the water quality benefits of using alternative embankment materials.

  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. For example, arsenic loadings from the Tailings Basin in Closure could be reduced by 20% if inert material was substituted for 40% of the LTVSMC coarse tailings (Pint, Tailings Basin Mitigation - Response to Question 4, June 8, 2009).

- Enhanced Tailings Basin Bentonite Cap – PolyMet proposes to install a bentonite amended cap to the Tailings Basin as a partial dry cover system at Closure. It is not clear how the bentonite cap would be affected by freeze/thaw cycles, which could result in cracks in the cap. Additional soil cover could be placed over the bentonite cap to minimize freezing and the development of cracks.

- Enhanced Tailings Basin Geomembrane 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 cover is 2.89 inches/year versus 3.58 inches/ year for the bentonite amendment, for a difference of 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% 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% reduction in Tailings Basin infiltration, which would probably result in a roughly proportional (~1 to 5%) reduction in seepage contaminant loadings. This modest improvement in seepage water quality comes at a high cost (estimated at $87 million for the geomembrane cover 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. A partial geomembrane cap is not recommended at this time.

- Surface seepage to Second Creek – Although most of the seepage from the Tailings Basin flows north and west toward the Embarrass River, some seepage from the Tailings Basin flows 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 surface seepage (estimated long term steady state rate of 290 gpm) to flow to Second Creek. This seepage is predicted to 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. Concerns remain that the long term release of relatively high sulfate seepage from the Tailings Basin to Second Creek would further contribute to methylmercury formation. Therefore, it is recommended 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 avoid what MPCA guidance describes as a high risk situation for promoting mercury methylation. It is recommended that this Second Creek seepage collection and pumping continue until the vertical well pumping terminates.

- Permeable Reactive Barrier – the predicted groundwater 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 4.1-79), which would create what MPCA guidance describes as a high risk situation for promoting mercury methylation in the wetlands and downstream lakes and could affect downstream wild rice. 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%. During mine operations, however, the groundwater seepage rate and residual sulfate concentrations after passage through the PRB (assuming 50% 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 rates and sulfate concentrations are lower. Assuming a 50% removal efficiency, a PRB could reduce sulfate concentrations in groundwater 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, it is recommended 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 groundwater 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.

- Tailings Basin Effluent Treatment – Under the Tailings Basin Alternative, vertical wells would capture seepage from the Tailings Basin and discharge it to the Lower Partridge River downstream of the Colby Lake outlet. Based on modeling results, the seepage is currently predicted to meet all surface water quality standards, although it would reduce the river's assimilative capacity. If seepage water quality would differ from predictions and exceed surface water quality standards, the seepage could be treated prior to discharge. This treatment could occur at the WWTF already proposed at the Mine Site or a second treatment facility could be constructed closer to the discharge point.

Recommended Monitoring Measures

PolyMet developed a proposed hydrology and 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 leakage, and Tailings Basin pond and seepage. The details of this monitoring program would be finalized during permitting. Several key monitoring activities identified elsewhere within this DEIS, which could apply to the Proposed Action and action alternatives, are briefly discussed below.

- Waste Rock Stockpiles – First, waste rock must be carefully monitored to ensure that it is placed in the correct stockpile. Then, close monitoring of the pH and water quality of collected leachate from the waste rock stockpiles is recommended to insure the effectiveness of the lime treatment in maintaining a relatively high pH of approximately 8 in order to limit metal solubility. If elevated concentrations are found in the collected leachate, *in situ* monitoring could be conducted to locate the source within the stockpiles. In addition, monitoring should be conducted to ensure that woody species do not get established in areas where they could damage the stockpile covers.

- West Pit – It is recommended that the water quality of the West Pit be monitored regularly during Closure (i.e., before pit overflow in Post-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 – It is recommended 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 – It is recommended 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.

- Ore spillage – Spillage of ore fines and rock has occurred at other mines through gaps in the sides of the railcars. Such spillage at the NorthMet Project would expose surface and groundwater along the rail tracks to contamination by reactive ore. PolyMet proposes to minimize this risk by placing fines in the center of the railcars to minimize spillage. Monitoring is recommended to determine the effectiveness of this proposed mitigation measure. Regular maintenance of the rail line to collect spilled ore or filling the gaps in the railcars may be required based on the extent of ore spillage.

- Tailings – It is recommended that the sulfur concentration and pH of the tailings be monitored regularly to ensure they remain below a specified percent sulfur and above a specified drainage pH to prevent the development of acidic conditions or increased solubility of metals within the Tailings Basin. If elevated sulfur concentrations are found, additional copper sulfate could be used during flotation or a finer grind could be used during processing. If depressed drainage pH values are found, limestone could be mixed in with the tailings prior to disposal in the Tailings Basin.

- Downgradient groundwater quality monitoring - It is recommended that groundwater quality downgradient of the Tailings Basin and waste rock stockpiles be monitored on a regular basis to ensure that actual groundwater quality is consistent with model predictions. Intermediate monitoring locations between these source areas and regulatory points of compliance (e.g., Dunka Road) are recommended to serve as "early warning" of any groundwater quality issues.

- 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 baseline 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 as compared with baseline conditions for streams draining wetlands unaffected by mining. In addition, the study includes an assessment of the sources of methylmercury in 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 (two of which receive seepage from the Tailings Basin) and five additional monitoring sites at the downstream Sabin and Wynne lakes.

  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.

- Aluminum monitoring – It is recommended that monitoring of both groundwater and surface water include both total and dissolved aluminum on a regular basis to ensure that the state water quality standard for dissolved aluminum (i.e., 50 to 200 µg/L in groundwater and Colby Lake and 125 µg/L in other surface waters) would be maintained.

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 elements with the potential for cumulative effects. Our analysis within this DEIS also identified the potential for cumulative effects to surface water hydrology and water quality. Neither the Final Scoping Decision Document nor this DEIS identified potential cumulative effects to groundwater. The NorthMet Project would supplant the existing seepage from the LTVSMC Tailings Basin and extend the duration of these impacts, but these impacts are localized and already incorporated in the groundwater quality models. As indicated in Section 4.1.1, there is no evidence of any off-site contamination from the LTVSMC operations and the extent of on-site contamination appears to be limited to localized soils and possibly groundwater. Although the Project would affect groundwater levels, this effect would be very limited geographically and temporally (e.g., groundwater levels would be restored once pit dewatering ceases) and not subject to any significant cumulative effects. The effects of mine pit dewatering are considered in terms of effects on surface water flows. Therefore, the scope of this cumulative effects 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 effects 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 DEIS supports this study area, although the potential for the Project to have effects on hydrology and water quality further downstream in the St. Louis River is identified and evaluated.

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 cannot be simply speculative, but should be included in government plans and budgets or, for private projects, have filed for required permits. For this assessment, the activities listed in Table 4.1-89 were considered to be reasonably foreseeable and within the geographic scope of this cumulative effects analysis and were considered (Figure 4.1-28).

Table 4.1-89 Summary of Activities included in the Water Resource Cumulative Effects Assessment

Activities	Watershed	Status	Type of Activity
Peter Mitchell Mine	Partridge River	Existing	Taconite mine
City of Hoyt Lakes	Partridge River	Existing	Municipal potable water withdrawal and wastewater treatment plant discharge
NorthMet Mine	Partridge River	Proposed	Copper nickel mine and processing plant
Mesaba Energy Project – East Range Site	Partridge River	Proposed	Integrated gasification combined cycle electric power generating station
Mesabi Nugget Phase I	Partridge River	Under construction	Iron ore processing facility
Mesabi Nugget Phase II	Partridge River	Proposed	Taconite mine
Minnesota Power Laskin Energy Center	Partridge River	Existing	Coal-fired power station
LTVSMC Pits 2/2E and 2W	Partridge River	Existing	Former mine pits that are still flooding
LTVSMC Pit 3	Partridge River	Existing	Former mine pit that is completely flooded and overflowing
City of Babbitt POTW	Embarrass River	Existing	Wastewater treatment plant
Area 5 NW Pit	Embarrass River	Existing	Former mine pit that is completely flooded and overflowing
NorthMet Tailings Basin	Embarrass River	Existing and proposed	Legacy Tailings Basin seepage
Arcelor Mittal Mines (Laurentian and East Reserve Mines)	Embarrass River	Existing and proposed	Taconite mine
City of Aurora	Embarrass River	Existing	Municipal potable water withdrawal and wastewater discharge
City of Biwabik	Embarrass River	Existing	Municipal potable water withdrawal and wastewater discharge
United Taconite	St. Louis River	Existing	Taconite mine
US Steel Minntac	St. Louis River	Existing	Taconite mine and pelletizing operation

4.1.4.1 Cumulative Effects on Hydrology

Cumulative effects on hydrology are discussed below for the Partridge River, the Embarrass River, and the St. Louis River. Cumulative hydrologic effects for each of these rivers were evaluated in terms of river geomorphology, which is primarily affected by bankfull flows with a general recurrence interval of approximately 1.5 years (Rosgen 1996), and low flows (e.g., 7-day, 10-year flow, or 7Q10 flow), which are critical for maintaining aquatic ecology. The magnitude of the hydrologic effects of these past, present, and reasonably foreseeable activities are not sufficient to significantly affect high flows or flooding (e.g., 100-year floods) in these rivers, which is likely several thousand cfs (e.g., highest measured instantaneous flow on the Embarrass River is 1,690 cfs over a 22-year period of record and 3,230 cfs on the Partridge River over a 40-year period of record, neither of which probably represent a 100-year storm event).

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. 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). 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.

Past, Present and Future Activities Affecting Hydrology in the Partridge River

There are several mines, the City of Hoyt Lakes wastewater treatment plant (WWTP), and Minnesota Power's Laskin Energy Center (power plant) that have withdrawn/discharged water in the past, and/or are currently withdrawing/discharging water that affect flows in the Partridge River (Figure 4.1-28). 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. 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.

As listed in Table 4.1-89, there are 9 past, present, and reasonably foreseeable future activities that could affect the hydrology of the Partridge River. The existing or predicted future hydrologic effects of these activities are briefly described below and summarized in Table 4.1-90.

- Peter Mitchell Mine – is an open-pit taconite mine. The mine consists of five areas, only one of which (Area 003) discharges to the Partridge River. Permitted discharges from Area 003 include seven mine pit dewatering outfalls (SD-006 to SD-012), treated shop drainage and runoff from Crusher 2 (SD-016), and sanitary sewage from Crusher 2 (SD-013), but only the mine pit discharges SD-009 and SD-010 and Crusher 2 discharge SD-016, with a collective maximum permitted discharge to the Partridge River of 29 cfs, are active. Mine pit dewatering at SD-010 is inactive at this time, however, there is a passive discharge due to pit overflowing. These discharges essentially form the origin of the Partridge River. There is currently little or no active mining occurring in Area 003 and none proposed under their current Mine Plan that would result in changes in discharge volumes.

  Pit dewatering records for the Peter Mitchell Mine from 1976 to approximately 1986 are available and show an annual average discharge to the Partridge River 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). Over the past several years (2004 to present), the average annual daily discharge from the Peter Mitchell Mine has been 5.8 cfs, but it quite variable ranging from zero (mostly during the winter and summer droughts) to as high as approximately 20 cfs in terms of monthly averages. Since there is no active mining and pit water levels have remained relatively stable, these discharges approximate surface and groundwater inflow to the Area 003 pits and do not represent any significant net increase or decrease in flow to the Partridge River.

Table 4.1-90 Cumulative Effects on Partridge River Hydrology by Activity

Activity	Average Hydrologic Effect	Location of Effects	Timing	Magnitude	Future Duration
Peter Mitchell Mine	0 cfs	Affects entire Partridge River	Intermittent	Varies	>20 years Ongoing
City of Hoyt Lakes	-0.1 cfs	Affects Lower Partridge River	Continuous	Relatively consistent	Long term Ongoing
NorthMet Mine	-3.4 to -10.5 cfs	Primarily affects Lower Partridge River	Intermittent	Varies	20 years beginning ~ 2012
Former LTVSMC pits	0 cfs	NA	NA	NA	NA
Mesaba Energy Project	-7.4 cfs	Primarily affects Lower Partridge River	Continuous	Relatively consistent	Long term beginning ~2013
Mesabi Nugget Phase I	-2.1 cfs	Affects Lower Partridge River	Continuous	Varies	Long term beginning ~2010
Mesabi Nugget Phase II	+11.8 cfs	Affects Lower Partridge River	Continuous	Varies from 7.2 to 33.5 cfs	20 years beginning ~2012
Laskin Energy Center	-4.2 cfs	Effects Lower Partridge River	Continuous	Relatively consistent	Long term Ongoing

- City of Hoyt Lakes – the City of Hoyt Lakes currently withdraws approximately 0.6 cfs of water from Colby Lake for municipal potable use. The City of Hoyt Lakes discharges approximately 0.5 cfs of treated wastewater from its POTW to Whitewater Reservoir. Most of this water is returned to the Partridge River watershed either via pumping during droughts to maintain water levels in Colby Lake or via seepage through its northwest dike to the Lower Partridge River. For purposes of this cumulative effects analysis, a consumptive loss of 0.1 cfs is assumed from the Partridge River watershed.

- NorthMet Mine Project - The NorthMet Project would reduce average flows in the Lower Partridge River as a result of redirecting drainage away from the Partridge River, reduction in groundwater baseflow, and process water withdrawals from Colby Lake. The average reduction in flow in the Partridge River varies by alternative, but ranges from 3.4 cfs (Tailings Basin Alternative - Max Recycle Option) to 10.5 cfs (Proposed Action)

- Former LTVSMC Pits – there are several former LTVSMC taconite pits that are in various stages of flooding. Pit 3 is the only pit that is overflowing, contributing an average of approximately 1.4 cfs to Wyman Creek, a tributary of the Partridge River. It is not known to what extent precipitation affects this flow rate. Since this discharge is the result of natural flooding of the pit and the discharge is not currently regulated, it is assumed for purposes of this cumulative effects analysis that the net contribution from Pit 3 is zero, as its contribution is already reflected in Partridge River flow.

Water levels in the other pits within the Partridge River watershed are either still in the process of flooding or are stable (i.e., groundwater discharges). The Mesaba Energy and Mesabi Nugget Phase I and II projects all propose to withdraw water from or dewater former LTVSMC Pits 1, 2E/W/WX, 3, 6, and 9S; the hydrologic effects of these projects are described below. The remaining pits are Pit 5S, which is full and discharges via groundwater to Wyman Creek, and Pit 9N, which is also full and discharges via groundwater to Pit 1. Since these two pits have natural groundwater discharges, which should be reflected in Partridge River baseflow, it is assumed for purposes of this cumulative effects analysis that their net flow contribution is 0 cfs.

- Mesaba Energy Project – is a proposed coal-fired power plant with a nominal 1,212 MW capacity. The U.S. Department of Energy (DOE) in cooperation with the Minnesota Department of Commerce prepared a DEIS for the project in November 2007. The DEIS identifies a preferred West Range Site located in the City of Taconite and outside the geographic scope of this cumulative effects analysis, as well as an alternative East Range Site located within City of Hoyt Lakes, just north of Colby Lake. Although not the preferred site, for purposes of this cumulative effects analysis, it is assumed that the Mesaba Energy Project would be built at the East Range Site.

  The Project would have average and peak water demands of 16.1 and 22.3 cfs, respectively, for cooling water, which could be withdrawn from various mine pits (i.e., Pits 1, 2E, 2W, 3, 6, 9S, NorthMet mine dewatering [although identified as a potential source in the Mesaba Energy EIS, the NorthMet Project recycles most of its water], and other area pits), and potentially Colby Lake (DOE 2007). Approximately 7.4 cfs of this demand would be consumed by evaporative cooling. The extent to which this evaporative loss of water would affect flow in the Partridge River is unclear, as some of the water may be withdrawn from former mine pits (e.g., Pits 2E/W/WX) that are still flooding and not really contributing to surface flows. For purposes of this cumulative effects analysis, it is assumed that the Mesaba Energy Project would result in an evaporative loss of up to 7.4 cfs under average flow conditions in the Lower Partridge River.

- Mesabi Nugget Phase I – is currently under construction and will produce iron nuggets from iron ore concentrate at a rate of 600,000 metric tons per year. The concentrate will come from the Northshore taconite facility in Silver Bay, Minnesota via rail and truck and from the nearby proposed Mesabi Nugget Phase II project. The concentrate will be mixed, dried, and fed into a rotary hearth furnace where it will undergo reduction to metallic iron and slag material.

  The facility will have an average and maximum water demand of 4.5 and 11.1 cfs, respectively, for contact and non-contact cooling and process water. This water will be withdrawn from the Area 1 and/or Area 2WX pits. The process water will be routed to a wastewater treatment system, which will discharge at an average and maximum rates of 2.4 and 9.0 cfs, respectively to Second Creek. The project will have evaporative losses of approximately 2.1 cfs.

- Mesabi Nugget Phase II – is a proposed project involving reactivation of a taconite mine and construction of a new taconite concentration facility. The iron ore concentrate would be used as feedstock for the Mesabi Nugget Phase I Project, with the remaining balance shipped by rail for use in other facilities. The project is currently undergoing NEPA and MEPA review.

The Mesabi Project would discharge water during mining operations to either Second Creek or directly to the Partridge River from Area 1, Area 6, and Area 2WX pits. The water management strategy for this facility is still in the process of development, however, preliminary estimates are provided below. During Years 1 and 2, approximately 33.5 cfs would be discharged from Area 2WX Pit and Area 6 Pit. During Years 3 to 10, approximately 12.0 cfs would be discharged from Area 1, 2WX, and 6 pits. During Years 11 to 20, approximately 7.2 cfs would be discharged from Area 1 and 2WX pits only. Therefore, the Mesabi Project is expected to increase flows in the Partridge River during the 20-year mine period by an average of approximately 11.75 cfs (Barr 2009, Proposed Water Management Plan for the Mesabi Nugget Phase II Project).

- Laskin Energy Center – is a coal-fired power plant that withdraws cooling water from Colby Lake. It discharges once-through non-contract cooling water in the downstream portion of Colby Lake, but has a 4.2 cfs evaporative loss of water to the atmosphere.

In general, from the mid-1950s, when the LTVSMC and Peter Mitchell mines began operations, until around the year 2000, mining has probably increased average flow in the Partridge River as a result of pit dewatering, although at various times it may have decreased flows temporarily depending on the stage of mine development. Discharge records for these mines are not available for most of this period, making it difficult to draw firm conclusions. Since LTVSMC stopped operations in 2001 to the present, the net effect of the on-going activities (i.e., Peter Mitchell Mine discharge, City of Hoyt Lakes withdrawal, and Laskin Energy Center evaporative losses) is an average annual reduction in flow of approximately 4.3 cfs in the Partridge River in comparison to natural flow. The net effect of the proposed activities (including the NorthMet Project) would be an additional net average reduction in flow (in comparison to natural flow) of approximately 1.1 cfs (assuming the Tailings Basin Alternative – Maximum Recycle Option) to as much as 8.2 cfs (assuming the Proposed Action) for at least the next 20 years or so. At some point in the future (20+ years), the existing and proposed mining projects (i.e., Peter Mitchell Mine, NorthMet Mine, Mesabi Nugget Phase II) would stop operating and pit dewatering cease. The only known projects that would remain operating at that point would be projects involving consumptive use (i.e., evaporative losses), which could result in a reduction in average annual flow of 7 cfs (without Mesaba Energy Project) to 14 cfs (with Mesaba Energy Project).

It is important to note that this discussion of the effects of various activities on average flow masks important temporal and spatial differences. The uncertain timing of particularly the mine discharges makes quantifying the effects of these activities on daily flows very difficult. For example, the dewatering pumps at the Peter Mitchell Mine do not operate continuously and this factor alone can affect flows on a daily basis in the Partridge River by as much as 20 cfs based on recent operations and as much as 29 cfs based on authorized discharges. These large pit dewatering discharges, however, are typically related to either snow melt or large storm events when flows in the Partridge River are high, reducing the significance of these discharges. On the other hand, there is often no discharge from the Peter Mitchell Pit during drier summer months when river flows are less. It should also be noted that the NorthMet and Mesabi Nugget II projects are both proposed to begin operations about the same time and to some extent offset each others impacts for about the same duration (about 20 years), as the NorthMet Project would reduce flows in the Lower Partridge River by 3.4 to 10.5 cfs (varying by alternative) while the Mesabi Nugget Project would increase flows in the Lower Partridge River by an average of 11.8 cfs as a result of its pit dewatering activities. Figure 4.1-29 provides a summary of the flow effects of these reasonably foreseeable activities over the next 70 years based on current estimates of when the various activities would begin operations. The Figure provides two flow totals, one including all of the reasonably foreseeable activities and a second that excludes the Mesaba Energy Project, as this project's preferred site is outside of the study area and it has a relatively large consumptive use (7.4 cfs), which can distort the results.

The hydrologic effects of these various activities would also vary spatially. The Upper Partridge River (above Colby Lake) is currently only affected by the Peter Mitchell Pit, which currently does not appear to affect flow on an annual average basis. The NorthMet Project would reduce flows in the Upper Partridge River by an average of 1.5 cfs. In terms of the Lower Partridge River, all of the reasonably foreseeable activities discussed above would affect flows in the lower river, with a net reduction in average annual flow of approximately 1.1 to 8.2 cfs, depending on which NorthMet alternative is assumed. Flow in the Lower Partridge River (and water levels in Colby Lake), however, is also affected by the Whitewater Reservoir diversion works, which receives water from Colby Lake (i.e., Partridge River) during high flows, but can return water via pumping to Colby Lake and the Partridge River during low flows. The operation of Whitewater Reservoir can therefore offset to some extent the hydrologic effects of these reasonably foreseeable activities in the Lower Partridge River, especially during particularly high or low flow periods. When water levels fall below 1,439.0 feet msl due to low inflows, the MnDNR Water Appropriation Permit limits withdrawals of water from Colby Lake to the rate that water can be pumped from Whitewater Reservoir to replace the water withdrawn. This permit limits helps to maintain a minimum flow of approximately 13 cfs (equivalent to flow release at Colby Lake elevation of 1,439.0 feet) except during extreme droughts when water levels in Colby Lake would naturally fall below elevation 1,439.0.

Effects of Hydrologic Changes on High Flows and River Geomorphology

In terms of river geomorphology, the small reduction in annual average flow in the Upper Partridge River from the NorthMet Project (approximately 1.5 cfs) would have little effect on channel morphology. The overall net reduction in average flow in the Lower Partridge River of up to approximately a maximum of 13 cfs is small (<1%) relative to high flows (1,960 cfs is the average annual maximum 1-day flow) and should have little effect on sediment deposition or transport. As indicated above, the maximum discharges from the Peter Mitchell Pit tend to occur during high flow events, but even here the approximately maximum 20 cfs contribution from the Peter Mitchell Pit would only represent about a 1% increase in average annual maximum 1-day flow. To the extent that current and projected future activities (i.e., Mesabi Nugget Phase II) may increase flow, the reduction in flow from the NorthMet Project 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.

Effects of Hydrologic Changes on Low Flows and Aquatic Ecology

In terms of low flows, the identified activities would have a modest effect on low flows in the Upper Partridge River on an annual average flow basis (net reduction of 1.5 cfs), although operation and timing of discharges from the Peter Mitchell Pit could compound low flows.

The impact of the identified activities on low flows is ameliorated to some extent downstream of Colby Lake because of the potential to offset water withdrawals with pumping from Whitewater Reservoir. The aquatic life of the Lower Partridge River are accustomed to low flows approximating 13 cfs as Colby Lake has been at or below the lake elevation that equates to this flow (i.e., elevation 1,439.0 feet) 7.5% of the time since LTVSMC stopped operating, and was at or below this elevation over 25% during LTVSMC operations (Table 4.1-15). There are no proposed withdrawals of water from the Partridge River downstream of Colby Lake, only pit dewatering discharges from Mesabi Nugget Phase II and possibly the discharge of Tailings Basin seepage from the NorthMet Project under the Tailings Basin Alternative. These discharges would offset to some extent the upstream withdrawals. The net effect of the Project, in combination with other activities, would be more frequent and longer duration low flow releases from Colby Lake relative to existing conditions, which could impact aquatic resources in the lower three miles of the Partridge River. Low flows reduce available habitat for aquatic species and, depending on the time of year, these low flows could interfere with spawning for fish that use shallow water habitat.

Summary

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 from the NorthMet Project could increase the frequency and duration of low flows in the Lower Partridge River and contribute to adverse cumulative effects on the downstream aquatic community. These adverse effects are limited both temporally (for about the 20-year life of the NorthMet mine) and spatially (for about the lower 3 miles of the Partridge River until the confluence with the St. Louis River).

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. There are two USGS gaging stations located within the Embarrass River watershed (#04017000 located about three miles northwest of the Tailings Basin and #04018000 located about 7 miles southwest of the Tailings Basin); they provide flow records for 22 and 9 years respectively. Table 4.1-17 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) flow at monitoring station PM-13 as 9.7, 85.5, and 857.1 cfs, respectively.

Past, Present and Future Activities Affecting Hydrology in the Embarrass River

In general, flows in the Embarrass River have been affected to a minor extent by municipal water withdrawals and wastewater discharges, and since the mid-1950s by mining (e.g., seepage from the LTVSMC Tailings Basin). Most of these discharges are relatively continuous, although there can be significant variation in the magnitude of the discharges, most of which are attributable to precipitation trends. Larger discharges tend to coincide with either snow melt or large storm events when flows in the Embarrass River are typically high, thereby reducing the significance of these discharges. On the other hand, there can be little or no discharge during drier periods when river flows are less. As listed in Table 4.1-89, there are 6 past, present, and reasonably foreseeable future activities that could affect the hydrology of the Embarrass River. The existing or predicted future hydrologic effects of these activities are briefly described below and summarized in Table 4.1-91.

Table 4.1-91 Cumulative Effects on Embarrass River Hydrology by Activity

Activity	Average Hydrologic Effect	Location of Effects	Discharge Timing	Magnitude	Duration
City of Babbitt POTW	+0.1 cfs	Upper and Lower Embarrass River	Continuous	Relatively consistent	Long term Ongoing
Area 5 NW Pit	0 cfs	Upper and Lower Embarrass River	Continuous	Varies	Long term Ongoing
NorthMet Tailings Basin	-1.7 cfs to +4.5 cfs	Lower Embarrass River	Continuous	Relatively consistent	Long term beginning ~2012
Arcelor Mittal Mine (Laurentian and East Reserve mine pits)[1]	+9.3 cfs	Lower Embarrass River	Continuous	Varies	Until ~2025 Ongoing
City of Aurora	-0.32 cfs	Lower Embarrass River	Continuous	Relatively consistent	Long term Ongoing
City of Biwabik	0.0	Lower Embarrass River	Continuous	Relatively consistent	Long term Ongoing

[1] Laurentian Mine is expected to close in approximately 2013. The 9.3 cfs is the single combined permitted discharge for all Arcelor Mittal mine pits.

- City of Babbitt – the City of Babbitt uses several wells, some of which are in the Dunka River watershed) as its water supply source, and discharges 0.33 cfs of treated wastewater effluent to the headwaters of the Embarrass River. Since some of this discharge is Dunka River watershed water, it is assumed that the City of Babbitt provides an annual average net increase of 0.1 cfs to the Embarrass River.

- Pit 5NW – recently began overflowing to Spring Mine Creek, a tributary of the Embarrass River. It contributes an average of 2.0 cfs, but its flow does vary with precipitation and has been measured as low as 0.23 cfs. Since this is a natural groundwater discharges, which should be reflected in Embarrass River baseflow, it is assumed for purposes of this cumulative effects analysis to have a net flow contribution of 0 cfs.

- NorthMet Tailings Basin – seepage from the NorthMet Tailings Basin would vary depending on the recommended alternative. Relative to existing conditions, predicted seepage ranges could range from an average 1.7 cfs reduction in seepage under the Tailings Basin Alternative to an average 4.5 cfs increase in seepage under the Proposed Action.

- Arcelor Mittal Mines – encompasses the Laurentian Mine and the East Reserve Mine. The Laurentian Mine is a taconite mine that has been in operation since approximately 1993 with a current average production rate of 9 million long terms per year. The mine has three permitted dewatering discharges to an unnamed tributary to the Lower Embarrass River (immediately downstream of Esquagama Lake), but only one is actively used (SD003).

  Pit dewatering discharges averaged approximately 5.6 cfs annually between 2005 and 2008 (Laurentian Mine DMR Summary Reports, 2005, 2006, 2007, and 2008). Discharges varied widely by month with high flows typically occurring in the spring (maximum monthly average over 4-year period was 7.3 cfs) and low flows typically occurring in winter (minimum monthly average over 4-year period was 0.0 cfs). Flows similar to these are expected over the next 2 to 5 years, after which the mine is scheduled to close in 2013 and the discharge would cease and the pit allowed to flood.

- The East Reserve Mine – is an open-pit taconite mine, which just began operations of its first pit (East Reserve #1) in 2008. The second pit (East Reserve #2) is permitted, but is not yet in operation and is not expected to open for several more years. Ore from the East Reserve #1 pit is currently being blended with, and will gradually over the next 4 to 7 years replace, ore from the Laurentian Mine.

  The mine has a single permitted dewatering discharge (SD005) to an unnamed tributary to the Lower Embarrass River (immediately downstream of Esquagama Lake). Pit dewatering discharges from East Reserve #1 are currently averaging approximately 1.6 cfs so far in 2009, but this discharge will gradually increase as the pit gets deeper. At some yet to be determined point, East Reserve #2 will be opened and pit dewatering will begin through a single permitted discharge (SD006). The Laurentian Mine and East Reserve Mine (Pit #1 and 2) would have a single combined permitted discharge of 9.3 cfs. This discharge will be to another unnamed tributary that joins with the East Reserve #1 discharge tributary prior to its confluence with the Embarrass River.

- City of Aurora – the City of Aurora withdraws approximately 0.32 cfs from the St. James Pit, a former natural ore pit within the Embarrass River watershed, and discharges approximately 0.31 cfs of treated wastewater to Silver Creek, which drains to the St. Louis River. Therefore, this withdrawal represents a loss of water from the Embarrass River watershed.

- City of Biwabik – the City of Biwabik withdraws approximately 0.25 cfs from the Canton Pit for municipal water supply and discharges treated wastewater to a tributary of Embarrass Lake at approximately the same rate. There is effectively no net loss of water associated with the City's water usage.

The hydrology of the Upper Embarrass River (i.e., upstream of monitoring station PM-12) remains relatively natural, with only a small wastewater discharge from the City of Babbitt WWTP (net +0.1 cfs). Pit 5NW overflow (net 0 cfs to Spring Mine Creek) and seepage from the LTVSMC Tailings Basin (ranging from -1.7 cfs [Tailings Basin Alternative] to +4.5 cfs

[Proposed Action]) have a modest effect on the hydrology of the Middle Embarrass River (i.e., between PM-12 and inlet to Sabin Lake). The Lower Embarrass River (from Sabin Lake to the confluence with the St. Louis River) is affected by mine pit dewatering and some minor municipal water withdrawals and wastewater discharges. The Embarrass River chain of lakes (from Sabin Lake to Esquagama Lake) tend to regulate changes in upstream flow.

Overall, the identified activities would result in an annual average increase in flow in the Embarrass River of about 5 to 10 cfs in the short term (i.e., until 2013 when the Laurentian Mine is expected to close), about 2 to 7 cfs in the midterm (i.e., from 2013 to 2025 when the Mittal Steel mine is expected to close), and from a slight reduction in flow to an increase of about 4 cfs in the long term (i.e., after 2025).

Effects of Hydrologic Changes on High Flows and River Geomorphology

In terms of river geomorphology, high flows tend to most affect the geomorphology and stability of river channels. The maximum net modification in flow resulting from the above referenced projects (approximately 10 cfs) is small (about 1%) 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.

Effects of Hydrologic Changes on Low Flows and Aquatic Ecology

The potential increase in average annual flow in the Embarrass River may result in a slight increase in low flows as well. Any increases in minimum flows would generally be considered beneficial to the aquatic community.

Summary

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 have any significant adverse effects on river geomorphology under high flows or the aquatic community under low flows.

St. Louis River

The St. Louis River drains an area of approximately 3,584 square miles in northeastern Minnesota. The river flows from its source at the outlet of Seven Beaver Lake approximately 194.5 miles to Lake Superior at the Superior Entry at the City of Duluth.

The St. Louis River has many tributaries. The Partridge and Embarrass rivers are in the headwaters of the basin and join the St. Louis River at RM 160 and 139, respectively. The Whiteface and Cloquet rivers are the primary tributaries and join the St. Louis River much further downstream (approximately RM 78 and 51). Although there are many lakes within the St. Louis River Basin, there are relatively few along the mainstem of the St. Louis River itself, with the impoundment formed by Knife Falls Dam in Cloquet at RM 35.5 being the most upstream.

The average annual flow of the St. Louis River measured at Scanlon is 2,284 cfs (based on daily data), with average annual high and low flows of 14,617 and 465 cfs, respectively. The maximum flow was nearly 38,000 cfs (MnDNR 2006). Table 4.1-92 provides a summary of selected USGS stream gage data and statistics for the St. Louis River based on water years (October – September).

Table 4.1-92 St. Louis River Basin Annual Mean Data: Gage Summary (source: USGS)

USGS Gage #	Location	Catchment area (mi^2)	Period of Record (annual means)	Average flow (cfs)	Average contribution per mi^2 (cfs/mi^2)
04016500	St. Louis River near Aurora, MN	277	1943 - 1987	238	0.86
04018750	St. Louis River at Forbes, MN	713	1965 - 1989	559	0.78
04024000	St. Louis River at Scanlon, MN	3,430	1909 - 2008	2,284	0.69

From these figures, the average contribution per unit area for the St Louis River is 0.82 cfs/mi^2 (not using the Scanlon figures since the gage is so far from the project area), compared to the yield from the Embarrass River (0.69 cfs/mi^2), and the Partridge River (0.81 cfs/mi^2). Using the calculated total catchments at the Partridge/St. Louis confluence and the Embarrass/St. Louis confluence, these figures were used to estimate average flows at these locations (Table 4.1-93).

Table 4.1-93 Estimated St. Louis River Average Flows at Partridge and Embarrass River Confluences

Location	Total catchment (mi^2)	Estimated average flow from catchment area contributions (cfs)
Partridge River above St. Louis confluence	151.3	123
Embarrass River above St. Louis confluence	175.2	121
St. Louis River at the Partridge River confluence	425.6	348
St. Louis River at the Embarrass River confluence	640.6	502

There are two mining activities within the Upper St. Louis River Basin that are considered in this cumulative effects assessment:

- United Taconite – is a taconite mine that began operations in 1965 and has an annual capacity of approximately 5.2 million gross tons of taconite pellets. The United Taconite Thunderbird Mine has six permitted mine pit dewatering discharges, all of which discharge to the St. Louis River Basin, although only two discharges (SD005 and SD007) have been active in the past three years. United Taconite also has three permitted tailings basin seep discharges, all of which discharge to the St. Louis River Basin, but only one of which is actively discharging (SD001). Seepage from the tailings basin is rather diffuse and discharge SD001 only captures a portion of this seepage. Total discharges average approximately 7.0 cfs. No changes in mine operations or discharges are anticipated in the foreseeable future.

- US Steel Minntac – is a taconite mine and pelletizing operation in Mountain Iron, Minnesota. The mining area has three active permitted pit dewatering outfalls (SD001, SD003, and SD004), all of which discharge to tributaries of the St. Louis River. Pit dewatering discharges averaged approximately 14.2 cfs annually between 2005 and 2008 (US Steel – Minntac Mining Area DMR Summary Reports, 2005, 2006, 2007, and 2008). Discharges varied widely by month with high flows typically occurring in the spring (maximum monthly average over 4-year period was 40.3 cfs) and low flows typically occurring in late summer or fall (minimum monthly average over 4-year period was 5.0 cfs).

Table 4.1-94 summarizes the net hydrologic effect of identified activities within the Partridge and Embarrass River watersheds on the St. Louis River as well as the two mining activities within the St. Louis River watershed. In general, the activities within the Partridge River watershed are expected to reduce its flow contribution to the St. Louis River, while activities within the Embarrass River watershed are expected to increase its flow contribution to the St. Louis River by approximately the same level of magnitude. There could be individual years, depending on the operations of specific mines, which could result in more significant increases or decreases in flows, but these estimates become very speculative. United Taconite and US Steel Minntac are both dewatering pits and discharging to the St. Louis River watershed. There are no current plans to modify the operations at United Taconite or US Steel Minntac, so no net hydrologic changes are expected from those two activities.

Table 4.1-94 Cumulative Effects on St. Louis River Hydrology by Activity

Activity	Hydrologic Effect	Location of Effects	Discharge Timing	Magnitude	Duration
Partridge River activities	-10 to +5 cfs	Partridge River	Varies	Varies	Varies
Embarrass River activities	-2 to +10 cfs	Embarrass River	Varies	Varies	Varies
United Taconite	+7.0 cfs	St. Louis River	Varies	Varies	Long Term Ongoing
US Steel Minntac	+14.2 cfs	St. Louis River	Intermittent	Varies (5.0 - 40.3 cfs)	Long Term Ongoing

Effects of Hydrologic Changes on High Flows and River Geomorphology

The potential net effect of these activities on high flows is a potential increase on the order of 15 cfs. Increases in flow on this order of magnitude would have little detectable effect on the geomorphology of the St. Louis River. The St. Louis River at Scanlon has an average annual high flow of 14,617 cfs and a maximum flow of 38,000 cfs. A 15 cfs increase in flow would represent approximately a 0.1% increase, which would be easily within the range of natural variability and would have no effect of the geomorphology of the St. Louis River.

Effects of Hydrologic Changes on Low Flows and Aquatic Ecology

The potential net effect of these activities on low flows is a potential decrease on the order of 12 cfs. Decreases in flow on this order of magnitude would have a minor adverse effect on low flows, which in turn affects the health of the aquatic community present in the river. The St.

Louis River at Scanlon has an average annual low flow of 465 cfs. A 12 cfs decrease in flow would represent approximately a 2.5% decrease, which could result in minor adverse effects. However, if the Mesaba Energy Project is not included, since its preferred site is located outside of the St. Louis River Basin, the reduction in flow is more likely to be approximately 5 cfs. A reduction of flow of this magnitude would only represent approximately a 1% change in the average annual low flow and would be within the range of natural variability and would have no significant adverse effect on the aquatic life of the St. Louis River.

Summary

In summary, the cumulative effects of past, present, and reasonably foreseeable future actions on the hydrology of the St. Louis River would not be expected to have any significant adverse effects on river geomorphology under high flows or on the aquatic community under low flows.

4.1.4.2 Water Quality

Cumulative effects on water quality are discussed below for the Partridge River, the Embarrass River, and the St. Louis River.

Partridge River

Recent (collected by PolyMet between 2004 and 2009) and historic (back to 1956) water quality data are available for various constituents in various locations along the Partridge River (Table 4.1-21). These water quality data 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 is little or no water quality data available from the mainstem of the Partridge River that predate the operation of the Peter Mitchell Mine in 1956 that can be used to characterize relatively “undisturbed” conditions. There are, however, six samples that were collected by MnDNR in 1976 and 1979 along the South Branch of the Partridge River, which is unaffected by mining, that can provide some insights on “undisturbed condition” water quality in the Partridge River for several key parameters (Table 4.1-23). As these few samples suggest, the Partridge River under “undisturbed conditions” would likely meet all surface water standards, although total aluminum (150 ug/L) and iron (856 ug/L) reflect the naturally elevated concentrations common to this part of the state. Sulfate concentrations averaged 5.2 mg/L.

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 last 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, with the possible exception of mercury.

Water quality in Colby Lake is affected by inflow from the Upper Partridge River watershed, but also anthropogenic effects from mine pit dewatering and overflows (e.g., Peter Mitchell Mine in the headwaters; several former LTVSMC pits), 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. Colby Lake is not included in Minnesota's regional mercury TMDL because the mercury concentrations in the fish are too high to be returned to Minnesota's mercury water quality standard through reductions in atmospheric mercury deposition alone. A TMDL pollution reduction study has not yet been performed for Colby Lake to address this impairment.

The NorthMet Project is expected to meet all surface water quality standards under all flow conditions for all mine years in the Partridge River.[80] 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 4.1-95). Therefore, this cumulative effects analysis will focus on mercury (only parameter on 303(d) list) and sulfate (because of its relationship with mercury methylation and wild rice).

Table 4.1-95 Predicted Upper Partridge River Concentrations as a % of Standard

Parameter	Standard	Modeled Existing Conditions	% of Standard	Proposed Action 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[(1)]	2.1	25.3	7.0	84.3
Nickel	46.5[(1)]	1.9	40.9	25.6	55.1
Zinc	96.1[(1)]	24.2	25.2	24.6	25.6

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration at that location.

Sulfate

According to available surface water monitoring data, including sulfate sampling conducted as part of the recent wild rice field survey (Barr, *Draft 2009 Wild Rice and Sulfate Monitoring*), sulfate concentrations in the Upper Partridge River (average of 5 to 6 mg/L during the wild rice survey and an average of 6 to 10 mg/L during historic monitoring) are generally consistent with the baseline conditions found in the South Branch of the Partridge River in the 1970s (5.2 mg/L),

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

80 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.

despite periodic Peter Mitchell Pit dewatering discharges that average about 57 mg/L.[81] Recent sampling in Colby Lake (Figure 4.1-25) found a mean concentration of 17 mg/L. Downstream of Colby Lake, sulfate concentrations increase as the result of groundwater seepage (e.g. Pit 6 with an average flow of about 4.7 cfs and sulfate concentration of 1,217 mg/L), overflow (i.e., Pit 3 with an average flow of 1.4 cfs and sulfate concentration of 79 mg/L), dewatering (i.e., Pit 1 with an average flow of 8.9 cfs and sulfate concentration of 385 mg/L), and surface seepage (i.e., Cell 1E of the LTVSMC Tailings Basin with an average seepage of 1.2 cfs [550 gpm] and sulfate concentration of 155 mg/L). Sulfate concentrations increase to an average of 30.4 mg/L downstream of the outlet of Colby Lake (Mesabi Nugget monitoring location MNSW14) and to an average of 149 mg/L downstream of the confluence with Second Creek at the County Road 110 bridge (Mesabi Nugget monitoring location MNSW12). The wild rice survey found sulfate concentrations as high as 289 mg/L below Second Creek during a relatively dry period.

The baseline sulfate concentrations found in the Partridge River reflect the effects of discharges from existing activities within the watershed. Table 4.1-96 summarizes the relative sulfate load contributions from the various identified activities in the watershed. In terms of proposed activities, the NorthMet (Tailings Basin Alternative) and Mesabi Nugget Phase II projects have the greatest potential to affect sulfate concentrations in the Partridge River.

Table 4.1-96 Cumulative Sulfate Loadings to the Partridge River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Sulfate Concentration (mg/L)	Average Sulfate Load (kg/d)
Peter Mitchell Mine	5.8	57	806
City of Hoyt Lakes	0.5	~0	~0
NorthMet Mine	2.6[(1)]	174	2,080[(2)]
Mesaba Energy Project	16.1	487	19,185
Mesabi Nugget Phase I	8.9	385	8,383
Mesabi Nugget Phase II	7.2 to 33.5 (avg. = 11.8)	125.7 to 191.5 (avg. = 146.3)	2,214 to 15,695 (avg. = 4,564)
Laskin Energy Center	194	No change in loading	0
LTVSMC Pits 2E/2W	0	45 / 119	0
LTVSMC Pit 3	1.4	79	269

1 Represents West Pit overflow.
2 Includes West Pit overflow as well as 969 kg/d average groundwater contribution of sulfate to the Partridge River.

The NorthMet Project is predicted to increase average sulfate concentrations in the Upper Partridge River from about 9 to a maximum of 14 mg/L, from about 9 to 13 mg/L in Colby Lake, and from about 30 to 32 mg/L downstream of the Colby Lake outlet, and from about 149 to 150 mg/L downstream of the confluence with Second Creek, primarily as a result of groundwater seepage and eventually the West Pit overflow.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[81] It is the tribal cooperating agencies' position that the wild rice standard for sulfate applies on the Lower Partridge River.

The proposed Mesabi Nugget Phase II Project would discharge significant sulfate loadings from the Area 1, 2WX, and 6 pits to the Lower Partridge River over the 20 years of mine operations. During the first two years of operation, approximately 33.5 cfs of water containing 192 mg/L of sulfate would be discharged from Area 2WX and Area 6 pits. During Years 3-10, approximately 12.0 cfs of water containing 161 mg/L of sulfate would be discharged from the Area 1, 2WX, and 6 pits. During Years 11-20, approximately 7.2 cfs of water containing 126 mg/L of sulfate would be discharged from the Area 1 and 2WX pits.

Although the NorthMet Project would have fairly minor effects on sulfate concentrations in the Partridge River, the cumulative effects of past, present, and reasonably foreseeable future activities have resulted in a significant increase in sulfate concentrations from baseline conditions of approximately 5 mg/L to the existing concentration of 149 mg/L downstream of the confluence with Second Creek, which is expected to increase further as a result of the NorthMet and Mesabi Nugget Phase II projects.

The cumulative effect of sulfate on mercury in the Partridge River watershed is discussed below.

Mercury

Based on the results of the baseline sampling program, PolyMet estimates that current total mercury concentrations average about 3 ng/L in the Upper Partridge River at the USGS gage (RS74A, Barr 2008) and between 4.8 and 6.0 ng/L in Colby Lake. Colby Lake is on the Minnesota 303(d) TMDL list because of mercury concentrations in fish tissue. Colby Lake is not included in Minnesota's regional mercury TMDL because the mercury concentrations in the fish are too high to be returned to Minnesota's mercury water quality standard through reductions in atmospheric mercury deposition alone. A TMDL pollution reduction study has not yet been performed to address this impairment.

The baseline mercury concentrations found in the Partridge River reflect the effects of discharges from existing activities within the watershed. Table 4.1-97 summarizes the relative mercury contributions from the various identified activities in the watershed. Research indicates that contact with Duluth Complex rock actually decreases total mercury concentrations to between 1.9 and 3.2 ng/L (RS53/42, SRK 2007). Other research has found that taconite tailings are also effective in sequestering mercury from seepage. Water quality sampling indicates that most area mine pits (11 out of 14 sampled) meet the 1.3 ng/L standard for mercury (Borovsky 2009). Therefore, mining itself is not expected to result in significant discharges of mercury. The greatest potential effect of the proposed activities on mercury is the potential for sulfate to promote mercury methylation. In terms of proposed activities, the NorthMet (Tailings Basin Alternative) and Mesabi Nugget Phase II projects have the greatest potential to affect sulfate, and potentially methylmercury, concentrations in the Partridge River.

Table 4.1-97 Cumulative Mercury Loadings to the Partridge River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Mercury Concentration (ng/L)	Average Total Mercury Load (kg/d)
Peter Mitchell Mine[1]	5.8	~1	4.3E-05
City of Hoyt Lakes	0.5	~0	~0
NorthMet Mine	2.6	Unknown[2]	NA
Mesaba Energy Project	16.1	Unknown	NA
Mesabi Nugget Phase I	8.9	Unknown	NA
Mesabi Nugget Phase II	7.2 to 33.5 (avg. = 11.8)	0.4 to 0.6 (avg. = 0.46)	7.0E-06 to 4.9E-05 (avg. = 1E-05)
Laskin Energy Center	194	No change in loading	0
LTVSMC Pits 2E/2W	0	0.87 / 1.61	0
LTVSMC Pit 3	1.4	0.65	2.2E-06

[1] DMR from 2004 to 2009
[2] Expected to be less than 1.3 ng/L.

The Project would result in increased sulfate loadings via groundwater to the Partridge River. The data suggest that the transport of sulfate from the waste rock/lean ore stockpiles to the Partridge River would involve very little interaction with wetlands. 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.

The 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 upstream of the Colby Lake outlet. There are few riparian wetlands and no lakes downstream of Colby Lake. As a result, the Project is not expected to contribute to cumulative impacts on downstream waters that are already on the 303(d) list.

Both Tailings Basin Alternative options would capture most Tailings Basin seepage and discharge it to the Partridge River downstream of Colby Lake, which would increase sulfate loadings to the Lower Partridge River. The Lower Partridge River is not considered a high risk area with few riparian wetlands and no lakes downstream, therefore, the Tailings Basin Alternative is not expected to contribute to additional cumulative effects on mercury concentrations in water or fish tissue in the Partridge River watershed.

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). These lakes are not covered by the Statewide Mercury TMDL, but are impaired waters and are still in need of a TMDL pollution reduction study. These waters are not included in Minnesota’s regional mercury TMDL because the mercury concentrations in fish are too high to be returned to Minnesota's mercury water quality standard through reductions atmospheric mercury deposition alone.

Water quality data (ranging from 1955 to 2007) are available for various parameters at three locations along the Embarrass River (Table 4.1-27). 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.[82]

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 4.1-98). 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 4.1-98 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	20.7(1)	4.1	19.8	6.7	32.4
Nickel	115(1)	6.7	5.8	14.2	12.3
Zinc	264(1)	12.6	4.8	34.5	13.1

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 250 mg/L.

Sulfate

According to available surface water monitoring data, including sulfate sampling conducted as part of the recent wild rice field study (Barr, *Draft 2009 Wild Rice and Sulfate Monitoring*), sulfate concentrations in the Upper Embarrass River average 4.6 mg/L at PM-12, which is considered a relatively undisturbed site unaffected by mining, but receiving a 0.33 cfs wastewater discharge from the City of Babbitt. Sulfate concentrations increase in the Middle Embarrass River (between PM-12 and Sabin Lake) to an average of 36.1 mg/L at PM-13 and 33.3 mg/L at a location downstream of PM-13, but above Sabin Lake. This increase in sulfate concentrations is primarily attributable to the Pit 5NW overflow (average flow of 2.0 cfs and sulfate concentration of 1,046 mg/L) and seepage from the LTVSMC Tailings Basin (average

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[82] The position of tribal cooperating agencies is that the wild rice standard for sulfate applies.

flow of 4.5 cfs and sulfate concentration of 155 mg/L under the Proposed Action). The Embarrass chain of seven lakes tend to attenuate the sulfate concentrations by dilution, deposition, and biological uptake, with concentrations gradually declining in a downstream direction from 21 mg/L in Embarrass Lake to 17.1 mg/L at the outlet from Esquagama Lake, based on results from the recent wild rice survey. Sulfate concentrations in the Lower Embarrass River downstream of the chain of lakes are not available.

The baseline sulfate concentrations found in the Embarrass River reflect the effects of discharges from existing activities within the watershed. Table 4.1-99 summarizes the relative sulfate load contributions from the various identified activities in the watershed.

Table 4.1-99 Cumulative Sulfate Loadings to the Embarrass River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Sulfate Concentration (mg/L)	Average Sulfate Load (kg/d)
City of Babbitt POTW	0.33	~0	~0
Area 5 NW Pit	2.0	1,046	5,119
NorthMet Tailings Basin	4.5	149 to 241 (avg. = 183)	1,640 to 2,653 (avg. = 2,013)
Arcelor Mittal Mine (Laurentian and East Reserve Mine)	9.3	186	4,232

The NorthMet Project is predicted to increase average sulfate concentrations in the Middle Embarrass River (between PM-12 and Sabin Lake) from 33 to about 53 mg/L (as predicted at PM-13). This increase in sulfate concentrations is expected to be partially attenuated as it flows downstream through the Embarrass chain of lakes, but would still result in an increase in average sulfate concentrations at the downstream lakes (Table 4.1-67). The Tailings Basin Alternative would redirect most Tailings Basin seepage away from the Embarrass River watershed and discharge it to the Partridge River. Both Tailings Basin Alternative options would reduce average sulfate loading below existing conditions (Table 4.1-85). [83]

The cumulative effect of sulfate on mercury in the Partridge River watershed is discussed below.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[83] 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). Monitoring of an unnamed stream to the northwest of the Tailings Basin (PM-11) shows a total mercury concentration of 1.8 ng/L and an average methylmercury concentration of 0.25 ng/L, despite an average sulfate concentration of 88 mg/L (2008 data).

The baseline mercury concentrations found in the Embarrass River reflect the effects of discharges from existing activities within the watershed. Table 4.1-100 summarizes the relative mercury contributions from the various identified activities in the watershed. As discussed above, research indicates that mining itself is not expected to result in significant discharges of total mercury, rather the greatest risk is the potential for sulfate discharges/releases to promote mercury methylation.

Table 4.1-100 Cumulative Mercury Loadings to the Embarrass River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Mercury Concentration (ng/L)	Average Total Mercury Load (kg/d)
City of Babbitt POTW	0.33	~0	~0
Area 5 NW Pit	2.0	0.74	3.6E-06
NorthMet Tailings Basin	4.5	NA(1)	NA(1)
Arcelor Mittal Mines (Laurentian and East Reserve Mine)	9.3	2.1	4.7E-05

1 Expected to be less than 1.3 ng/L

The NorthMet Project would not have any surface water discharges to the Embarrass 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 favorable conditions for increased mercury methylation (relative to background conditions). 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 also 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 (2006) recommends avoiding "discharges" of sulfate, 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 additional sulfate to several high risk situations for mercury methylation. It is unclear to what extent increased sulfate loadings may have on mercury methylation within the downgradient wetlands and downstream lakes. PolyMet is conducting additional sampling in the wetlands, streams, and downstream lakes under a MPCA approved plan to help better understand mercury dynamics in the Project area. In summary, the Project may contribute to cumulative effects on methylmercury concentrations in 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. Both Tailings Basin Alternative options would reduce sulfate loading below existing conditions and, therefore, would not contribute to additional cumulative effects on mercury concentrations in water or fish tissue in the Embarrass River watershed.

St. Louis River

In the mid-1990s, the St. Louis River Management Plan described the water quality of the upper reaches of the St. Louis River and its tributaries as “generally good for most general water quality parameters.” The Plan identified mercury and mine leachate as “issues of concern.” These remain as issues of concern today. Most of the St. Louis River is listed on the 303(d) list of impaired waters for “mercury in fish tissue,” while segments of the Lower St. Louis River (downstream of Knife Dam at RM 35.5) are also listed for mercury in the water column, PCBs in fish tissue and the water column, DDT, and dieldrin. The St. Louis River is not covered by the Statewide Mercury TMDL, but is an impaired water and is still in need of a TMDL pollution reduction study. The other impairments (i.e., PCBs, DDT, and dieldrin) are not related to mining. Therefore, this cumulative effects assessment will focus on mercury and sulfate, as these are the two key parameters that the NorthMet Project could influence in the St. Louis River.

Sulfate

Sulfate concentrations vary up and down as the St. Louis River flows downstream from its confluences with the Partridge and Embarrass rivers, and ranges from a low of 3 mg/L to a high of 106 mg/L (Table 4.1-101). It has long been known that sulfate concentrations in the St. Louis River are sometimes elevated due, most likely, to mining related sulfate releases, especially during dry periods when less surface runoff is available for dilution (Lindgren et al. 2006). Sulfate concentrations in waters draining non-mining impacted watersheds (e.g., Cloquet, Whiteface and Floodwood rivers) ranged from 3.4 to 5.8 mg/L, whereas sulfate concentrations in tributaries from mining impacted watersheds ranged from 22 to 127 mg/L (Bavin and Berndt 2008). The effects of the US Steel Minntac Mine discharge (average of 14.2 cfs and 257 mg/L sulfate) is reflected in the increase in the sulfate concentration in the St. Louis River at the confluence with East Two River (Table 4.1-101). The activities included in this cumulative effects assessment, which include several mining projects, have the potential to increase sulfate concentrations.

The wild rice report (Barr, *Draft 2009 Wild Rice and Sulfate Monitoring*) considered the St. Louis River, although based on aerial photo interpretation, most of the river between the confluence with the Embarrass River and Cloquet did not appear to have suitable habitat to support wild rice. The field surveys did not find any rice along the St. Louis River near Brookston, an area identified as potentially having wild rice from historic photographs (NAIP 2008). Sparse stands of wild rice were found along short stretches of the lower St. Louis River near its outlet into Lake Superior. A large, dense stand (approximately 30 acres) was identified in Pokegama Bay, a bay that flows into the St. Louis River. The identified activities in this cumulative effects assessment would have little, if any, effect on the wild rice in Pokegama Bay, as this is a tributary of the St. Louis River.

Table 4.1-101 Sulfate Concentration along the St. Louis River

River Mile	Location	No. of Samples	Mean	Range
179	St. Louis River	5	3.3	2.0 to 7.9
160.6	at Partridge River confluence	5	77	14 to 189
142	St. Louis River	9	35	12 to 70
139	at Embarrass River confluence	5	27	18 to 41
133	St. Louis River	4	2.7	2.2 to 3.7
125	St. Louis River	5	43	15 to 68
119.8	at East Two River confluence	6	106	82 to 127
119.5	at West Two River confluence	6	71	50 to 99
115	St. Louis River	4	42	21 to 72
97	at Swan River confluence	9	18	7 to 27
80	St. Louis River	5	37	17 to 67
78.5	at Whiteface River confluence	5	4.5	2.8 to 6.5
71.7	at Floodwood River confluence	6	3.1	0.8 to 7.1
53	St. Louis River	9	28	10 to 53
51.3	at Cloquet River confluence	6	3.1	2.5 to 3.4
51.0	St. Louis River	4	16	11 to 22
46.5	St. Louis River	4	17	12 to 30
40.5	St. Louis River	4	15	11 to 20
38.5	St. Louis River	4	15	11 to 21
36	St. Louis River	8	15	5.0 to 28

The cumulative effect of sulfate on mercury in the St. Louis River is discussed below.

Mercury

Balogh et al. (2006) studied tributaries of the Rum River, located just south of the St. Louis River watershed and found sulfate was transported in the river mostly during dry periods when total mercury and methylmercury concentrations were low. High total mercury and methylmercury concentrations were only observed during periods of high flow when waters from surrounding wetlands were dominating river impact. Although Lindgren et al. (2006) did not measure methylmercury, their results show a direct relationship between flow volume and total mercury and an inverse relationship between flow and sulfate in the St. Louis River system.

Recent research by Baven and Bundt (2008) found little or no correlation between sulfate and either methylmercury or total mercury. In summer, the relative importance of specific mechanisms affecting methylmercury production and transport within the St. Louis River watershed is currently unknown.

The 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 a downstream lake that may stratify in order to reduce the potential for methylmercury production. The St. Louis River has relatively few riparian wetlands and no lakes, at least in its middle segment between the confluence with the Embarrass River (RM 139) and Knife Falls Dam (RM 35.5). Most of the St. Louis River would be considered a low-sulfate water by MPCA's definition, but generally the flow remains in the channel and is therefore not exposed to wetlands or lakes until it reaches the impoundments near Cloquet (RM 35.5) and Lake Superior. Little information is available on the extent of methylmercury formation in these impoundments or the Lake Superior estuary. Overall, the Project is not expected to contribute significantly to cumulative effects on mercury or methylmercury in the St. Louis River.

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) Section 404 permits and Section 401 certificates, the State of Minnesota's Wetland Conservation Act (WCA), the MnDNR's Public Waters Work Permit Program, and MPCA's Wetland Standards and Mitigation Rules (*Minnesota Rules*, part 7050.0186).

Although permits are required from 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" waters, including wetlands, are not regulated, but "incidental" wetlands may be. 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 water quality certification 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, therefore, 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.[1]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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 4.1-68 for a summary of water quality impacts). MPCA should be afforded the opportunity to certify or deny certification of the Proposed Action.

photography; and, where available, soils and hydrology information.[2] Final wetland locations were field delineated and characterized from 2004 to 2008 (Figures 4.2-1 through Figure 4.2-4).[3]

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 Babbitt-Eaglenest complex 0-8% slopes (ELT 13) and 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; 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*). Wetland hydrology at the Plant Site has been affected by the operation of the LTVSMC Tailings Basin. Evidence suggests that hydrologic changes from

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[2] 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.

[3] 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.

Tailings Basin seepage, along with beaver dams, have resulted in inundation of wetland areas immediately north of the Tailings Basin (Barr 2008; *Lined Tailings Basin Alternative – EIS Data Request*).[4]

The soils and hydrology at the Mine Site support a stable wetland systems comprised in large part by bog communities represented by open and coniferous bogs, as well as shrub carr/alder thicket dominated by alder and willows, and forested swamp communities comprised of hardwood and coniferous trees.[5] Most of the wetland vegetation present at the Mine Site (72 percent) is indicative of acid peatland systems (e.g., open and coniferous bogs) that are dependent on precipitation rather than groundwater for hydrologic inputs and reflect a perched water table. There are other wetland communities present at the Mine Site, such as shrub swamps (12 percent), forested swamps (9 percent), and wet/sedge meadows (4 percent) that may receive some portion of its hydrology from groundwater. The remaining shallow marsh community (3 percent) generally results from artificial impoundment by beaver dams, roads, and railroads and is primarily dependent on surface waters for hydrology.

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

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[4] 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.

[5] 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.

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, 2007, and 2008 (RS14, Barr 2006; RS14, Barr 2007; and Barr 2008, *Memorandum: Wetland Impacts – Tailings Basin Mitigation Alternative*, Revised June 2, 2008). 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 covering 1,302 acres within an overall area of approximately 3,016 acres at the Mine Site and an additional 57 acres in 30 wetlands along the transportation corridor (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), including approximately:

- 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 uppermost stratum of vegetation is comprised primarily of shrubs.[6] Swamps are emergent

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[6] 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.)

wetlands in which the uppermost stratum of vegetation is comprised primarily of trees. Sedge meadows are wetlands dominated by plants in the Cyperaceae family.[7] Marshes are wetlands with emergent, herbaceous vegetation that includes sedges and other emergent plants, but is not dominated by plants in the Cyperaceae.[8]

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.[9] Shrubs are usually ericaceous (belonging to the heath family) and/or speckled alder and raspberry. Sphagnum moss comprises an almost continuous mat with interspersed, non-dominant forbs such as bunchberry and blue bead lily along with sedges and grasses.[10] Hydrologically, this complex is characterized by a relatively stable water table (RS44, Barr 2006).[11] 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. Wetland 27 has some fill and therefore was rated as moderate quality.[12]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[7] 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.)

[8] 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.)

[9] 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.

[10] 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).

[11] 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.

[12] Tribal cooperating agencies take the position that the canopy cover and herbaceous layer noted above indicate significant groundwater inputs to the wetland communities.

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. 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, which is primarily attributable to seepage from the basin (Barr 2008, *Memorandum: Wetland Impacts – Tailings Basin Mitigation Alternative*, May 28, 2008). 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. 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 June 2, 2008).[13]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[13] 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.

Transportation Corridor

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.

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 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 Habitats 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, vegetative diversity/integrity, and support of recreational activities. Both the USACE and WCA use MnRAM (3.3 is the latest version) for rating wetland functions 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;
- vegetative diversity/integrity;
- 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 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 area are tabulated in Table 4.2-3. The Overall Wetland Quality Rating was based on professional judgment and considered several wetland functions and degree of human disturbance (RS14, Barr 2006, *Wetland Delineation and Wetland Functional Assessment Report*). The plant community diversity/integrity ratings incorporate two principal components: integrity and diversity (MnRAM). 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 a 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, vehicle emissions, and noise.

4.2.3 Environmental Consequences

4.2.3.1 Proposed Action

The Proposed Action would result in both 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 at the Tailings Basin). This section describes these impacts within each of these areas and provides a summary of wetland impacts by project period or time frame. Estimates of both direct and indirect wetland impacts have changed during the EIS process as the result of refined analysis. The impacts identified in this DEIS are based on the most current information available and may differ from those identified in prior reports.

Potential Direct Wetland Impacts

The direct wetland impacts estimated for the Proposed Action would be the result of excavation, filling, or other activities that would result in wetland loss and loss of wetland functions and values. Total estimated direct wetland impacts for the Proposed Action are estimated at 854.2 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, 55 wetlands, totaling 804.3 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 (510 acres) and open bog communities (76 acres). These two communities comprise 73% of the direct wetland impacts at the Mine Site (Table 4.2-4).[14]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[14] 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.

Table 4.2-3 Total Projected Direct and Indirect Wetland Impact Detail

Project Area	Wetland ID	Dominant Circular 39 Type	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	0.0	shallow marsh	Moderate	Moderate	High	Impounded	Natural	Y	Direct
Mine Site	3	3	0.4	0.0	shallow marsh	Moderate	Moderate	High	Impounded	Natural	N	Direct
Mine Site	5	2	0.6	0.0	wet meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	6	3	0.6	0.0	shallow marsh	Moderate	Moderate	High	Impounded	Natural	Y	Direct
Mine Site	7	2	0.1	0.0	wet meadow	Moderate	Moderate	High	Impounded	Natural	N	Direct
Mine Site	8	2	6.2	0.0	sedge meadow	Moderate	Moderate	High	Impounded/Fill	Natural	Y	Direct/Indirect
Mine Site	9	3	0.5	0.0	shallow marsh	High	High	Moderate	Impounded	Natural	Y	Direct
Mine Site	10	2	1.2	0.0	sedge meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	11	8	0.0	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	12	6	0.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	13	2	0.3	0.0	wet meadow	High	High	High	Impounded	Natural	Y	Direct
Mine Site	14	2	0.3	0.0	wet meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	15	8	0.0	2.8	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	16	3	0.2	0.1	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	18	3	18.9	0.0	shallow marsh	High	High	Moderate	Impounded	Natural	Y	Direct
Mine Site	19	3	1.7	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	20	2	21.3	0.6	sedge meadow	High	High	Low	N/A	Natural	N	Direct/Indirect
Mine Site	22	3	0.0	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	24	6	0.8	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	25	8	0.0	2.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	27	8	1.1	0.0	coniferous bog	Moderate	Moderate	High	Road Fill	Natural	Y	Direct
Mine Site	29	3	2.3	9.7	shallow marsh	High	High	Low	N/A	Natural	Y	Direct
Mine Site	32	8	63.6	6.3	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	33	6	8.5	15.5	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	34	6	1.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	37	6	2.4	0.0	shrub carr	High	High	Low	N/A	Natural	N	Direct
Mine Site	43	6	8.3	0.1	alder thicket	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	44	6	2.0	1.3	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	45	6	20.6	10.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	47	8	0.5	0.0	open bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	48	8	40.2	58.2	Coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	51	6	2.9	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	52	6	2.7	1.1	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	53	6	2.7	0.5	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	54	6	0.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	55	6	3.6	0.3	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	56	8	0.0	2.8	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	57	7	54.7	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	58	6	0.1	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	60	6	6.0	0.0	alder thicket	High	High	Low	N/A	Natural	Y	Direct
Mine Site	61	7	0.0	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	62	8	0.0	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	64	7	0.0	0.0	hardwood swamp	High	High	Low	N/A	Natural	N	Direct

Project Area	Wetland ID	Dominant Circular 39 Type	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	68	7	7.3	12.8	hardwood swamp	High	High	Low	N/A	Natural	N	Direct
Mine Site	72	7	0.6	0.8	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	74	7	6.1	0.0	hardwood swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	76	8	2.4	1.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	77	8	7.8	5.2	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	78	8	0.8	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	79	8	0.0	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	80	8	0.3	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	81	7	1.2	0.5	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	82	8	60.2	1.4	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	83	8	3.7	0.3	open bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	84	8	1.3	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	85	8	1.4	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	86	8	2.5	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	88	8	4.0	1.6	coniferous bog	High	High	Low	N/A	Natural	N	Direct/Indirect
Mine Site	90	8	71.9	112.8	open bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	95	8	2.5	0.0	coniferous bog	High	High	Low	N/A	Natural	N	Direct
Mine Site	96	8	16.4	0.9	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	97	8	1.7	1.9	coniferous bog	High	High	Low	N/A	Natural	N	Direct/Indirect
Mine Site	98	8	15.5	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	99	8	0.6	0.9	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	100	8	117.7	25.6	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	101	8	7.2	7.9	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	103	8	116.4	9.5	coniferous bog	High	High	Low	N/A	Natural	Y	Direct/Indirect
Mine Site	104	8	3.1	0.5	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	105	8	0.0	0.0	coniferous bog	High	High	Moderate	Logged	Natural	Y	Direct
Mine Site	107	8	42.1	23.7	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	109	6	6.0	0.0	alder thicket	High	High	Low	Partly cleared	Natural	Y	Direct
Mine Site	114	8	0.7	0.0	coniferous bog	High	High	Low	N/A	Natural	Y	Direct
Mine Site	120	3	0.6	0.0	shallow marsh	Moderate	Moderate	Moderate	Impounded	Natural	Y	Direct
Mine Site	200	7	6.4	0.0	hardwood swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site	201	2	13.5	0.0	wet meadow	High	High	Low	N/A	Natural	Y	Direct
Mine Site	202	7	5.7	0.0	coniferous swamp	High	High	Low	N/A	Natural	Y	Direct
Mine Site Total	**76**		**804.3**	**318.6**		**69 High 7 Moderate**	**69 High 7 Moderate**					
Transportation Corridor												
Railroad	R-1	2	0.0	0.0	wet meadow	High	High	Moderate	Road fill	Natural	Y	None
Railroad	R-2	3	0.0	0.0	shallow marsh	High	High	Moderate	Road fill	Natural	Y	None
Railroad	R-3	7	0.1	0.0	hardwood swamp	High	High	Moderate	Road fill	Natural	Y	Direct
Railroad	R-4	6	0.2	0.0	shrub carr	High	High	Low	N/A	Natural	Y	Direct
Railroad	R-5	3	0.0	0.0	shallow marsh	High	High	Moderate	Impounded	Natural	Y	None
Railroad	R-6	3	0.0	0.0	shallow marsh	High	High	Low	N/A	Natural	Y	None
Railroad	R-7	6	0.0	0.0	shrub carr	High	High	Moderate	Impounded	Natural	Y	None
Railroad	R-8	6	0.0	0.0	shrub carr	High	High	Moderate	Impounded	Natural	Y	None
Railroad Subtotal	**8**		**0.3**	**0.0**		**8 High**	**8 High**					

Project Area	Wetland ID	Dominant Circular 39 Type	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	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
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**		**10.2**	**0.0**		**20 High 2 Moderate**	**20 High 2 Moderate**					
Transportation Corridor Total			**10.5**	**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**					

Project Area	Wetland ID	Dominant Circular 39 Type	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	T16[1]	4	5.5	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[1]	4	1.7	0.0	deep marsh	Low	Low	High	Impounded	Natural	Y	Direct
Buttress Area	T19[1]	4	9.0	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[1]	6	0.9	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
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**		**20.3**	**0.0**		**17 Low**	**17 Low**					
Tailings Basin Drain System	None	None	0.0	0.0								
Tailings Basin Indirect Impacts			0.0	349.3								
Tailings Basin Subtotal			39.4	349.3								
Project Total	**139**		**854.2**	**667.9**								

Source: RS20T, Barr 2008, *Wetlands Mitigation Plan Supplement*

[1] The impacts to the Buttress Area were revised to account for the additional wetland impacts (3.3 acres) of the modified buttress width north of the Tailings Basin. Detailed information on the specific wetlands impacts were not available; however, a relative area ratio was developed to approximate the additional impacts to wetlands T16, T18, T19, and T26.

Table 4.2-4 Summary of Total Project Direct and Indirect Wetland Impacts by Eggers and Reed Classification[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	14.8	27.8	25.6	0.0	0.0	2.4	65.2	19.8	62.2	76.1	509.5	0.0	804.3
	Indirect (acres)	0.0	0.0	0.6	9.8	0.0	0.0	0.0	28.8	12.8	1.3	113.1	152.2	0.0	318.6
	Total (acres)	0.0	14.8	29.3	35.4	0.0	0.0	2.4	94.0	32.6	63.5	189.2	661.7	0.0	1,122.9
	# wetlands	0	5	3	10	0	0	1	15	4	5	3	30	0	76
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	1	0	3	0	0	3	0	1	0	0	0	0	8
Dunka Road/Water Pipeline	(acres)	0.0	0.0	0.0	2.1	0.3	0.1	6.2	0.5	0.0	0.5	0.0	0.0	0.5	10.2
	# 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	1.7	0.0	3.0	10.7	3.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	19.1
	# wetlands	0	5	0	3	2	4	1	0	0	1	0	0	0	16
Tailings Basin - Buttress Area	(acres)	0.0	0.0	0.0	0.7	17.4	0.0	1.4	0.0	0.0	0.8	0.0	0.0	0.0	20.3
	# wetlands	0	1	0	1	5	0	5	0	0	5	0	0	0	17
Tailings Basin – Indirect Impacts	Indirect (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	349.2
Total	(acres)	0.0	16.5	29.3	41.2	28.4	3.7	10.3	94.5	32.7	64.8	189.2	661.7	0.5	1,522.1

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 percent of the projected direct wetland impacts at the Mine Site. In addition, 29 acres of sedge meadow, 26 acres of shallow marsh, 20 acres of hardwood swamp, 15 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 percent of the directly impacted wetlands are rated as high quality wetlands, with the remaining rated as moderate quality.

At Post-Closure (approximately Year 65), the West Pit would overflow and discharge water into wetland number 32 (Figures 4.1-22, 4.2-1, and 4.2-5), and then through a stream channel to the Partridge River. Wetland number 32 and the downstream channel would be modified to accommodate the predicted flow of 2.6 cfs. The direct impacts to wetland number 32 are included in the wetland impact direct totals (Table 4.2-3).[15]

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

PolyMet proposes to reuse the former LTVSMC Processing Plant and Tailings Basin. The processing plant is located on uplands with no wetland resources present. There are no jurisdictional wetlands within the Tailings Basin, but proposed modifications to the basin embankment (i.e., construction of a buttress) and expansion of the basin to the east would result in some direct wetland impacts.

Under the Proposed Action, construction of the buttress, which is necessary to meet geotechnical safety criteria (see Section 4.13), would extend approximately 140-feet from the existing toe of the north side of the Tailings Basin embankment, and an East Basin expansion would extent from the east and northeast sides of the Tailings Basin. The buttress construction would result in approximately 20.3 acres of direct wetland impacts involving 12 wetlands (Table 4.2-3 and Figure 4.2-2). All the impacted wetlands are rated as low quality, primarily because the hydrology supporting these wetlands has been modified by seepage from the Tailings Basin and other drainage modifications made in the area. These hydrologic modifications have resulted in inundation and changes in wetland cover types from forested and scrub shrub wetlands (as evidenced in aerial photographs from the 1940s prior to LTVSMC operations) to deep marsh (Barr 2008, *Lined Tailings Basin Alternative – EIS Data Request*). The East Basin expansion would result in approximately 19.1 acres of direct wetland impacts involving 14 wetlands (Table 4.2-3 and Figure 4.2-2). Wetland types affected 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 direct wetland impacts are anticipated with the Tailings

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[15] It is the position of the tribal cooperating agencies that because a stream channel can be seen in aerial photographs, the discharge would follow a stream channel through the aforementioned wetlands.

Basin drain system since the drains and pump station are planned to be constructed on the lower, existing bench of the tailings embankment. In summary, direct wetland impacts at the Tailings Basin would total approximately 39.4 acres.

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 10.2 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. All but 0.4 acres of the wetlands that would be directly impacted within the transportation corridor are rated high quality.

Potential Indirect Wetland Impacts

The determination of indirect wetland impacts from the Proposed Action took into consideration the following conditions:

- Changes in surface water or groundwater flow rates and patterns, which could affect wetland hydrology and result in the diminution of wetland functions and/or changes in wetland cover types;
- Changes in surface or groundwater quality, which could result in the diminution of wetland functions; and
- Non-hydrologic changes, such as habitat fragmentation and the effects of fugitive dust, noise, and vehicular emissions, which could result in the diminution of wetland functions.

For each area assessed for direct wetland impacts – Mine Site (including haul roads), Plant Site (including the Tailings Basin), and the 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 assessed and summarized below.[16]

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[16] 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[17]

The Proposed Action would change the hydrology of the Mine Site through the establishment (and dewatering) of mine pits, waste rock stockpiles, and a dike and ditch system that minimizes lateral movement of surface water and shallow groundwater within surface deposits. This drainage system was designed to minimize the amount of surface water flowing onto the Mine Site; eliminate process wastewater and non-contact stormwater flowing uncontrolled off the Mine Site; and minimize the amount of stormwater flowing into the mine pits. 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.

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 stormwater 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 hydrologic impacts associated with these remaining wetlands since watershed areas would be maintained closer to the existing conditions.

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 (Figure 4.2-7), and the size of the watersheds would change (Barr 2008, *Memorandum: Indirect Wetland Impacts at the Mine Site*). Wetlands within the interior of the Mine Site that are surrounded by or within 50 feet of haul roads, portions of the ditch and dike system, mine pits, and waste rock stockpiles would incur indirect impacts. These activities would affect wetlands by changing its hydrology, which could result in changes in wetland type, and by reducing its wildlife habitat functions and values as a result of habitat fragmentation and exposure to dust, vehicular emissions, noise, and human activity. These indirect wetland impacts at the Mine Site would total approximately 318.6 acres.

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[17] 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.

Wetlands at the Mine Site are believed to be primarily bogs, which are supported by direct precipitation with some variable surficial groundwater component from adjoining uplands.[18] Of wetland communities present at the Mine Site that could be at least partially dependent on groundwater for hydrology (i.e., wet meadow, sedge meadow, alder thicket, shrub carr, coniferous swamp, and hardwood swamp) only 83.3 acres are not already predicted to be either directly or indirectly impacted by the Proposed Action. This represents the upper bound of potential additional indirect wetland impacts on the Mine Site. Based on landscape position, at least 65 percent of this 83.3 acres appear to be at least partially supported by surface water (Wetlands 12, 53, and 58). These wetlands are not expected to be indirectly impacted and are not included in the 318 acres of indirect wetlands identified above.

Since PolyMet proposes to capture and treat all process water (i.e., any water touching disturbed ground), no indirect wetland impacts are expected related to surface water quality. In terms of groundwater quality, groundwater within the surficial aquifer at the Mine Site was generally found to meet groundwater evaluation criteria except for elevated concentrations of aluminum, iron, and manganese, which are assumed to be naturally occurring (see Section 4.1.1.2). Groundwater quality modeling predicts that the Proposed Action would result in exceedances of the antimony, manganese, nickel, and sulfate groundwater evaluation criteria in various locations and for various durations, some for very long periods (i.e., over 2,000 years). The groundwater evaluation criteria, however, are based on the actual or potential use of groundwater as a source of drinking water. Generally the Class 2B surface water standards (see Table 4.1-20) are used to protect wetlands (*Minnesota Rules* parts 7050.0186 and 7050.0222) as these standards were developed to maintain healthy aquatic and wetland communities. Predicted nickel concentrations in groundwater from the Category 3 Lean Ore and Category 3 Waste Rock stockpiles and possible antimony in groundwater from the Category 3 Waste Rock Stockpile would exceed the wetland standards. As discussed previously, however, most of the wetlands at the Mine Site are bogs that are believed to be hydrologically supported by perched water tables with little interaction with the underlying groundwater. Affected leachate from the Category 3 Lean Ore and Category 3 Waste Rock stockpiles would flow toward the Partridge River with no intervening wetlands that are groundwater dependent. Therefore, no indirect wetland impacts are anticipated at the Mine Site resulting from groundwater quality.[19]

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[18] 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.

[19] 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 water will have to comply with Minnesota water quality standards.

In summary, based on these potential changes to wildlife habitat and site hydrology, it is estimated that a total of 318.6 acres of wetlands are likely to be indirectly impacted by the Proposed Action, resulting in changes in wetland type, function, and/or value (Table 4.2-3 and Figure 4.2-5). The appropriate mitigation ratios and acceptable mitigation sites for the predicted indirect wetland impacts at the Mine Site would be determined by the USACE and the State during permitting.[20]

In addition to these predicted indirect wetland impacts at the Mine Site, the potential exists for additional indirect wetland impacts in areas beyond the Mine Site. These potential impacts are primarily related to the potential for groundwater drawdown from mine pit dewatering to adversely affect wetland hydrology. Based on empirical observations at taconite surface mining operations in the region, including the nearby Peter Mitchell Mine, little indirect hydrologic impacts to nearby wetlands have been observed from mine dewatering (Adams and Liljegren 2009). Experience at other mining sites in the Iron Range further support this conclusion (AMEC 2007; Barr 2009, Northeastern Minnesota Wetland Mitigation Inventory).[21] For these reasons, additional indirect impacts to wetlands associated with groundwater drawdown from pit dewatering is anticipated to be minimal, with little to no dewatering of wetlands expected outside the Mine Site.[22] Nevertheless, wetland monitoring would be required during Project operations and Closure over a larger area than the Mine Site (to be determined during permitting) to detect if any additional impacts occur. This monitoring would assess both wetland hydrology and vegetation. Compensatory wetland mitigation would be required for any indirect wetland impacts determined through this monitoring.[23] Additional recommendations regarding the wetland monitoring plan are provided in Section 4.2.4.3.

Transportation Corridor Indirect Wetland Impacts

The only potential indirect impacts related to the treated water pipeline or the Dunka Road improvements would be associated with dust and vehicle emissions that may occur during facility construction and operations.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[20] 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.

[21] 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).

[22] 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.

[23] 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.

Along the rail line, it is likely that ore rock and fines could escape through gaps in the rail cars during transport from the Mine Site to the processing plant. This ore, when oxidized could result in the release of sulfate and various metals to streams and wetlands crossed by the rail corridor. It is difficult to estimate the extent of possible ore spillage, although, in terms of the total volume of waste rock and ore that would be handled at the Mine Site, it is not expected to be a large volume. PolyMet proposes loading procedures to minimize the potential for spillage and indicates that any large rock that may spill would be recovered during routine track maintenance. Mitigation and monitoring measures addressing ore spillage are discussed in Section 4.1.3.5.

Overall, these indirect wetland impacts along the transportation corridor are considered minor and would not be expected to significantly affect wetland functions or result in changes to wetland cover types, therefore no indirect wetland impacts are predicted for the transportation corridor.[24]

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 reuse. The Tailings Basin would be designed not to overtop, so there would be no surface discharges. It is expected that surface seepage would occur from the basin, but PolyMet proposes a surface seepage collection system that would capture essentially all of the surface seepage and return it to the Tailings Basin until the seeps dry out.[25] Therefore, no indirect wetland impacts are expected at the Tailings Basin related to surface water discharge or seepage. None of the proposed activities at the Tailings Basin would result in any further habitat fragmentation of wetlands or significant increases in dust, noise, vehicular emissions or human activity (other than short term construction-related activities). Reuse of the LTVSMC Tailings Basin, however, would have the potential to result in indirect wetland impacts resulting from changes in groundwater hydrology and water quality, which are described below.

Indirect impacts to wetlands from inundation due to increased seepage from NorthMet Tailings Basin are likely based on indications of such impact from historic operation of Cell 2W (Figure 4.2-8). The magnitude of these 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. Essentially all wetlands within this zone of hydrologic modification were assumed to be indirectly impacted, not including those wetlands that would be directly impacted

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[24] 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.

[25] 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.

by the construction of the Tailings Basin buttress north of Cell 2E 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, *Lined Tailings Basin Alternative - EIS Data Request*).[26]

The indirect wetland impacts were determined using mapped wetlands overlaid on a 2003 aerial photograph.[27] There are approximately 547 acres of mapped wetlands within the evaluation area; however, some of the historic impacts from Cell 2W (approximately 197 acres) extended into the Cell 2E evaluation area. The remaining 350 acres of mapped wetlands do not appear to have been affected by the LTVSMC Tailings Basin operations. Based on the assumptions described above, all of the remaining 349.3 acres of mapped wetlands within the evaluation area are anticipated to be indirectly impacted by seepage from the NorthMet Tailings Basin.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[26] 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

[27] 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.

Groundwater quality monitoring at several wells completed in the surficial aquifer at or near the toe of the Tailings Basin found elevated concentrations for fluoride, molybdenum, sulfate, and total dissolved solids relative to the baseline well (GW-002, see Table 4.1-6). Based on these results, it was concluded that groundwater immediately downgradient of the Tailings Basin has been degraded by seepage from the basin, but there does not appear to be an overall trend, either increasing or decreasing, in the concentrations monitored. The areal extent of this impact is unknown due to the lack of a monitoring well network, but based on the limited data available, no offsite contamination has been documented and the water quality of nearby wells are consistent with baseline conditions in the region (Siegel and Ericson 1980; MPCA 1999).[28]

The results of transient flow modeling, which was used to predict groundwater quality downgradient from the Tailings Basin, indicate that only aluminum (maximum of 77 µg/L) would exceed the groundwater evaluation criteria of 50 to 200 µg/L (see Table 4.1-53). The predicted concentration of manganese would also exceed the secondary MCL (i.e., predicted maximum concentration of 193 µg/L versus an USEPA secondary MCL of 50 µg/L), but as indicated in Section 4.1.2.2, manganese concentrations below the state health-based HRL of 300 µg/L are not considered exceedances of groundwater evaluation criteria for purposes of this DEIS because baseline concentrations in local groundwater already exceed this standard.[29] As discussed at the Mine Site, the groundwater evaluation criteria used in Section 4.1 were

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[28] 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.

[29] 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.

developed to be protective of human health. Using the wetland water quality standards (*Minnesota Rules* parts 7050.0186 and 7050.0222, basically the Class 2B standards from Table 4.1-20), the results of the Tailings Basin modeling indicate that groundwater would meet all wetland water quality standards. Therefore, indirect wetland impacts from changes in groundwater quality are not expected.

The appropriate mitigation ratios and acceptable mitigation sites for the predicted indirect wetland impacts at the Tailings Basin would be determined by the USACE and the State during permitting. Although indirect impacts beyond the predicted 349.3 acres at the Tailings Basin are not expected, it is recommended that wetland monitoring be conducted during Project operations and Closure over a larger area (to be determined during permitting) to determine if any additional impacts would occur. In the event that the monitoring identifies adverse impacts, appropriate measures 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 have approximately 854.2 acres of direct wetland impacts (804.3 acres at the Mine Site, 10.5 acres along the transportation corridor, and 39.4 acres at the Tailings Basin) and 667.9 acres of indirect wetland impacts (318.6 acres at the Mine Site, none along the transportation corridor, and 349.3 acres at the Tailings Basin) for a total predicted impact of 1,522.1 acres.[30]

Of the 1,123 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 (76 percent of total wetland impact).[31] A total of 94 acres of impacts are predicted in alder thicket communities and 10 acres in shrub carr communities (together constituting 9 percent of impacts). Swamp impacts include 65 acres of coniferous swamp and 33 acres of hardwood swamp (8 percent of impacts). Remaining impacts include 29 acres of sedge meadow communities and 17 acres of wet meadow communities; deep marsh impacts of 28 acres and shallow marsh impacts of 41 acres; and 4 acres of shallow/open

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[30] As previously stated, tribal cooperating agencies disagree with these conclusions and take the position that that acreage totals for indirect impacts are underestimated.

[31] 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.

water wetland communities along with less than one acre of deepwater habitat. No direct or indirect wetland impacts to the 100 Mile Swamp have been predicted.[32]

The quality of wetlands affected is a key factor in determining effects on wetland functional values. Section 4.2.1.4 and Table 4.2-3 provide an assessment of wetland functional values, including evaluation of applicable wetland functions and ratings of the vegetative diversity/integrity value based on MnRAM guidelines. Approximately 70 percent of the total wetlands to be affected, either directly or indirectly, are high quality wetlands with about 6 percent rated as moderate quality and the remaining 24 percent as low quality. Wetlands at the Mine Site 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.

The potential exists for other, minor localized indirect wetland impact areas as a result of the Proposed Action.[33] Wetland vegetation and hydrology monitoring would be conducted to determine if any additional indirect wetland impacts would occur, and additional compensatory wetland mitigation would be required for additional indirect wetland impacts.

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 wetland system under the No Action Alternative than under the Proposed Action.

4.2.3.3 Mine Site Alternative

The proposed subaqueous disposal of Category 2, 3, and 4 waste rock into the East Pit and surface storage of Category 1 waste rock would reduce the total areal footprint of the waste rock stockpiles by approximately 33 acres, which would reduce direct wetland impacts at the Mine

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[32] 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.

[33] 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 4.1-68, the Project would result in water quality standards violations.

Site by approximately 7.6 acres, most of which is open bog, for a total direct impact under the Mine Site Alternative of 796.7 acres.

As with the Proposed Action, PolyMet proposes to capture and treat all process water (i.e., any water touching disturbed ground), so no indirect wetland impacts are expected related to surface water quality. Under the Mine Site Alternative, groundwater quality modeling predicts that all groundwater would meet applicable wetland standards (*Minnesota Rules* parts 7050.0186 and 7050.0222, basically the Class 2B standards from Table 4.1-20); therefore, no indirect wetland impacts attributable to water quality are expected under the Mine Site Alternative. The indirect wetland impacts resulting from changes in hydrology and reduction in habitat value would still occur at the same magnitude as in the Proposed Action – approximately 318.6 acres.

In summary, the Mine Site Alternative would result in approximately 796.7 acres of direct wetland impacts and 318.6 acres of indirect wetland impacts at the Mine Site.

4.2.3.4 Tailings Basin Alternative

In terms of wetlands, the Tailings Basin Alternative would modify the Proposed Action by conducting a Passive Reactive Barrier (PRB) demonstration test, constructing a water discharge pipeline from the Tailings Basin to the Partridge River, and installing vertical wells to capture and pump Tailings Basin seepage to the Partridge River. Other components of this alternative would not result in any discernible differences in direct or indirect wetland impacts as compared to the Proposed Action.

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, obtain wetland permits, and provide the require compensatory mitigation, as needed, prior to implementation.

The water discharge pipeline would be routed approximately 8.4 miles from the Tailings Basin southerly to a discharge point on the Partridge River (Feigum 2009). For 5.2 miles of its length, the pipeline would parallel and be constructed adjacent to the existing plant water supply pipeline from Colby Lake. The existing water supply pipeline was constructed above ground within a berm for reasons that are not entirely known, but believed to be attributable to bedrock outcrops and the need to insulate the pipe from freezing temperatures. For purposes of this DEIS, it is assumed that the proposed water discharge pipeline would be constructed in a similar manner. The corridor would be kept cleared of woody vegetation to allow for pipeline inspection and maintenance. Pipeline construction would disturb 5.2 acres of 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.[34] The Tailings Basin Alternative would result in 5.2 acres of direct wetland impacts associated with the water discharge pipeline, as well as the 39.4 acres associated with the buttress and East Basin expansion, for a total of 44.6 acres at the Tailings Basin.

The capture of approximately 95% of the NorthMet seepage and its discharge to the Partridge River would significantly reduce the rate of groundwater seepage from the Tailings Basin to the downgradient wetlands compared to the Proposed Action and would in fact represent a 83% reduction from existing conditions (i.e., predicted seepage from decrease from an existing 900 gpm to a maximum of 154 gpm; see Table 4.1-78). This reduction in seepage is expected to eliminate any additional indirect wetland impacts north of the Tailings Basin from approximately 349.3 acres under the Proposed Action, to approximately 0 acres under the Tailings Basin Alternative. It is not expected that this diversion of seepage would go so far as converting the existing wetlands to uplands. The total groundwater seepage rate (NorthMet seepage plus residual LTVSMC seepage from Cell 2W) would still exceed aquifer flux capacity during operations and Closure, so some limited inundation of wetlands is still expected to continue, but the inundation would only affect wetlands already indirectly impacted from the existing LTVSMC seepage.

The results of transient flow modeling, which was used to predict groundwater quality downgradient from the Tailings Basin, indicate that groundwater would meet all wetland water quality standards (*Minnesota Rules* parts 7050.0186 and 7050.0222, basically the Class 2B standards from Table 4.1-20). Therefore, indirect wetland impacts from changes in groundwater quality are not expected.[35] In summary, the Tailings Basin Alternative would result in 44.6 acres of direct wetland impacts and no indirect wetland impacts at the Plant Site.

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 for unavoidable impacts, 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 4.2.4.4.

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, including measures at the Mine and Plant sites and along the transportation corridor.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[34] 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.

[35] 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.

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 *Minnesota Rules* part 8420.0522), state compensatory mitigation requirements under state water quality standards (*Minnesota Rules* part 7050.0186), and the USACE *St. Paul District Policy for Wetland Compensatory Mitigation in Minnesota* (2009), which prioritizes the location of project-specific compensation to first replace lost wetlands on-site, then within the same watershed or county, and finally within adjacent watersheds. The primary goal of wetland mitigation is to restore high quality wetland communities of the same type, quality, function, and value as those to be impacted 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 five 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; 3) wetland preservation, 4) wetland creation; and, 5) upland buffers.

The USACE St. Paul District 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 St. Paul District's compensatory wetland mitigation policy (USACE 2009, *St. Paul District Policy for Wetland Compensatory Mitigation in Minnesota*), requirements for mitigation can exceed the 1.5:1 mitigation ratio if the impacted wetlands provide rare or exceptional functions.[36]

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 Summary of Wetland Mitigation Ratios

Regulation	Location of impact	Replacement	Minimum replacement ratio
Minnesota Administrative Rules			
	Minimum Replacement Ratios: Wetland Banking		
	>80% area or agricultural land	Outside bank service area	1.5:1
		Within bank service area	1:1
	<50% area, 50-80% area, and non agricultural land	Outside bank service area	2.5:1
		Within bank service area	2:1
	Minimum Replacement Ratios: Project-Specific		
	>80% area or agricultural land	Outside major watershed or out-of-kind	1.5:1
		Within major watershed and in-kind	1:1
	<50% area, 50-80% area, and non agricultural land	Outside major watershed or out-of-kind	2.5:1
		Within major watershed and in-kind	2:1
USACE			
	>80% area	Not in-place, out-of-kind or in-advance	1.5:1
		In-place, in-kind and in-advance	1:1
	<80% area	Not in-place, out-of-kind or in-advance	2.5:1
		In-place, in-kind and in-advance	2:1

Source: Wetland Conservation Act

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[36] 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.

PolyMet would ultimately need to satisfy both the federal and state mitigation requirements. The project is estimated to directly impact 854.2 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 854 up to 1,281 acres (i.e., 1:1 to 1.5:1 compensation ratios). The appropriate mitigation ratios and acceptable mitigation sites for the 667.9 acres of predicted indirect wetland impacts would be determined by the USACE and the State during permitting. Although not expected, in the event that the wetland monitoring identifies additional indirect impacts, appropriate measures would be implemented such as hydrologic controls or compensatory mitigation.

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; and
4. off-site in watersheds neighboring adjacent watersheds.

Each of these potential locations areas is described below.

On-Site Mitigation

In accordance with the USACE's St. Paul District Compensatory Wetland Mitigation Policy (USACE 2009, *St. Paul District Compensatory Wetland Mitigation Policy*) and state guidelines, the potential for creating wetlands on-site was considered first. Approximately 175 acres of on-site wetland creation opportunities were identified, most of which would occur at Closure (RS20T, Barr 2008, *Wetlands Mitigation Plan Supplement*). 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 to treat effluent from the WWTF and would not be eligible for mitigation credit).

Other possible methods of on-site mitigation that were evaluated included: 1) establishment of lacustrine, fringe wetland habitats in the areas adjacent to the mine pits; 2) establishment of wetlands in other Tailings Basin areas; 3) establishment 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) establishment of wetlands upstream of roads and stockpiles, and 6) establishment 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, Barr 2008, *Wetlands Mitigation Plan Supplement*). 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 that 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, Barr 2008, *Wetlands Mitigation Plan Supplement*). Other siting criteria used in the GIS analysis included potential wetland enhancement areas, potential wetland preservation areas, and potential wetland creation areas (RS20T, Barr 2008, *Wetlands Mitigation Plan Supplement*). 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; and
- 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; and
- 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 with 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 and Federal ownership. Discussions with the various State and Federal entities regarding wetland mitigation on their respective properties resulted in the following conclusions:

- The USFS 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 the NorthMet Project would be viable if PolyMet expended 1 to 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; and
- 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 nullified by the State courts. 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 and Federal 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 with the notable exception of ditch systems that exist in tens of thousands of acres of peatland complexes. In areas lacking significant alterations, wetland preservation and establishment of upland buffers constitute the primary methods to generate wetland compensation credits within the study area. 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, Barr 2008, *Wetlands Mitigation Plan Supplement*). 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 geomorphological 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 NWI 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 qualify as wetland restoration of enhancement (e.g., unaltered sites can qualify for regulatory compensation credits such as wetland preservation and upland buffers); 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.

For purposes of the Clean Water Act regulatory program, the term “highest potential” is not the applicable standard for evaluating compensatory mitigation. Rather, “practicable” is the standard used in conjunction with the fundamental goal of compensatory mitigation - replace lost wetland functions in-kind and in-place to the extent practicable. Potential compensation sites are not limited to those that are least difficult and/or least expensive. Sites that have some greater difficulty and/or cost may be practicable, particularly if they are the only sites that would meet the fundamental goal of compensatory mitigation. In the subject case, that goal is to replace approximately 1,488 acres of wetland impacts within the St. Louis River watershed or the larger Great Lakes watershed in Minnesota. Further, the majority of the compensation should consist of coniferous and open bog wetland types to meet the in-kind criterion (e.g., approximately 73% of the wetlands impacted at the Mine Site are composed of these wetland types).

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 the 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; and
- 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 MnDNR and USACE 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 to allow the site to be accepted as compensation for Wetland Conservation Act purposes. However, this requirement is not applicable to establish compensatory mitigation for Clean Water Act purposes; and

- 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 are 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; and
- 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; 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. 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, Barr 2008, *Wetlands Mitigation Plan Supplement*).

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.

<u>Hinckley Mitigation Site</u>

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, reed canary grass, and garlic mustard.

4.2.4.3 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 2005) 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. Monitoring locations would be chosen to include a representative sample of wetland types that occur in the monitoring area. 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; and

- Reference wetland sites should be monitored for comparison to potentially impacted wetlands.

4.2.4.4 Mitigation Summary

The Proposed Action would impact an estimated 854.2 acres of direct impacts and 667.9 acres predicted indirect impacts (see Table 4.2-4). PolyMet proposes a combination of on-site and off-site mitigation to meet its mitigation requirements. PolyMet's current mitigation proposal includes:

- On-site mitigation totaling 175 acres of wetland creation;
- Aitkin Site – 810 acres of wetland restoration and 123 acres of upland buffer preservation; and
- Hinckley Site – 313 acres of wetland restoration and 79 acres of upland buffer preservation.

Off-site wetland restoration of 1,123.2 acres would provide approximately 1,119.8 wetland mitigation credits. 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 4:1 ratio, resulting in an additional 50.6 wetland credits. The total offsite mitigation would provide 1,170.3 wetland mitigation credits. 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 116.7 additional wetland mitigation credits (at an assumed 1.5:1 ratio), for a total of 1,287 wetland mitigation credits.

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 impacted could potentially be 509.5 acres and the total coniferous bog wetlands compensated for would be 339.4 acres (based on assumed ratios), a 170.0 acre compensation deficit (Table 4.2-6). Most other wetland community types proposed to be directly impacted would be replaced with comparable wetland communities.

Total proposed on-site and offsite wetland mitigation proposal totals 1,287 mitigation credits (Table 4.2-6). Compensatory mitigation required for the predicted would exceed the direct impacts (854.2 acres), but may not be sufficient to satisfy the compensatory mitigation requirements for the 667.9 acres of indirect impacts for which the mitigation ratio has not yet been determined. Compensatory mitigation for any remaining indirectly 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.[37] This mitigation would focus on sites located within the St. Louis River/Great Lakes watershed in accordance with the federal Mitigation Rule, Corps policy, and overall requirements under the Clean Water Act.

The USACE requires a detailed compensatory mitigation plan for anticipated wetland impacts that would occur during the Project's first five years. A detailed mitigation plan must be submitted for each subsequent five year increment of wetland impacts to the USACE for approval. 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 4.2-7); 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 4.2-8). The unavoidable wetland impacts projected during the first five years total up to 986.2 acres. Within operating years 6 to 20, an additional 533.8 acres of wetlands (1,522 total acres over the 20-year life of the Project) would be directly and indirectly impacted (Table 4.2-7).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[37] 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.

Table 4.2-6 Summary of Proposed Wetland Mitigation for Direct Impacts

	Wetland Mitigation					**Wetland Impacts**		
	Aitkin Wetland Mitigation Area (acres)	**Hinckley Wetland Mitigation Area (acres)**	**Wetland Mitigation Total (acres)**	**Credit Ratio**	**Wetland Mitigation Credits**	**Proposed Direct Wetland Impacts (acres)**	**Compensation (acres) at 1.5:1**	**Total Wetland Compensation (acres)**
Restoration of effectively drained wetlands								
Off-Site Wetlands								
Deepwater	0	0	0	1:1	0	0.5	0	0
Type 1 Seasonally Flooded	0	20.1	20.1	1:1	20.1	0	13.4	13.4
Type 2 Fresh (Wet) Meadow	21.8	14.3	36.1	1:1	36.1	16.5	24.0	24.0
Type 2 Sedge Meadow2	47.1	39.1	86.2	1:1	86.2	28.7	57.5	57.5
Type 3 Shallow marsh	86.9	1.4	88.3	1:1	88.3	31.4	58.9	58.9
Type 4 Deep marsh	33.6	0	33.6	1:1	33.6	28.4	22.4	22.4
Type 5 Shallow, Open Water	0	0	0	1:1	0	3.7	0	0
Type 6 Shrub-Carr	83.9	87.1	171	1:1	171.0	10.3	114.0	114.0
Type 6 Alder Thicket	82.8	27.4	110.2	1:1	110.2	65.7	73.5	73.5
Type 7 Hardwood Swamp3	52.6	7.1	59.7	1:1	59.7	19.9	39.8	39.8
Type 7 Coniferous Swamp	89.1	8.4	97.5	1:1	97.5	63.4	65.0	65.0
Type 8 Open Bog	74.2	0	74.2	1:1	74.2	76.1	49.5	49.5
Type 8 Coniferous Bog	238.2	101.2	339.4	1:1	339.4	509.5	226.3	226.3
Restoration of partially drained wetlands								
Type 2 Sedge Meadow2	0	0.8	0.8	2:1	0.4	0	0.3	0.3
Type 7 Hardwood Swamp3	0	6.1	6.1	2:1	3.05	0	2.0	2.0
Off-Site Wetland Total	**810.2**	**313.0**	**1,123.2**	-	**1,119.8**	**854.1**	-	**746.6**
Upland Buffer	123.1	79.2	202.3	4:1	50.6	-	-	50.6
Off-Site Upland Total	**123.1**	**79.2**	**202.3**	**4:1**	**50.6**	-	-	**50.6**
Off-Site Mitigation Total	**933.3**	**392.2**	**1,325.5**	-	**1,170.3**	**854.1**	-	**796.6**
On-Site Wetland Mitigation Total	-	-	**175.0**	**1.5:1**	**116.7**	-	-	**116.7**
Totals	-	-	-	-	**1,287**	**854.1**	-	**913.3**

Table 4.2-7 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	0.5	0.0	8.2	0.0	0.0	0.0	24.1	10.7	1.1	94.8	127.2	0.0	266.6
	Total (acres)	0.0	27.9	14.7	29.2	0.0	0.0	2.4	82.5	25.6	63.3	141.3	553.2	0.0	940.1
	# wetlands	0	3	5	9	0	0	1	12	3	4	3	22	0	62
Transportation Corridor	(acres)	0.0	0.0	0.0	2.0	0.2	<0.1	6.3	0.5	0.1	0.4	0.0	0.0	0.5	10
	# wetlands	0	0	0	5	1	1	13	1	1	1	0	0	1	24
Tailings Basin	Direct (acres)	0.0	<0.1	1.8	3.7	24.9	3.5	1.4	0.0	0.0	<0.1	0.0	0.0	0.0	36.1
	Indirect (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Total (acres)	0.0	<0.1	1.8	3.7	24.9	3.5	1.4	0.0	0.0	0.8	0.0	0.0	0.0	36.1
	# wetlands	0	1	5	4	6	4	4	0	0	4	0	0	0	28
Total	(acres)	0.0	27.9	16.5	34.9	25.1	3.5	10.1	83.0	25.7	64.5	141.3	553.2	0.5	986.2

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.

Table 4.2-8 Summary of 5-Year Wetland Impacts and Mitigation[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, 1997
[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.

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 1.5:1 in accordance with USACE guidance and Minnesota Rules. Restoration monitoring would continue over the 20-year life of the Project, with milestones in compliance with performance standards established at 5 and 20 years (RS20T, Barr 2007). Interim performance standards should also be established for years 1, 2, 7, 10, etc. 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.

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 and Embarrass River watersheds (Figures 4.2-14 and 4.2-15). The consideration of past, present, and reasonably foreseeable actions provides the context for assessing the wetland cumulative impacts within the Partridge River watershed.

4.2.5.2 Cumulative Wetland Impacts - Partridge River Watershed

Study Area

The Partridge River watershed study area extends from the headwaters of the Partridge River upstream of the Peter Mitchell Mine to the confluence with the St. Louis River downstream of Hoyt Lakes, Minnesota. The MnDNR Census of the Land (MnDNR 1996, *Minnesota Census of the Land*) 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.[38]

Three additional data layers were used to identify human-affected areas, including:

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[38] 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.

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.

1859 Ceded Territory. The Fond du Lac, Grand Portage, and Bios Forte tribes retains treaty guaranteed rights to harvest natural resources within the 1859 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 1859 ceded territory.
2. The loss of wetlands and changes in wetland functional values in the 1859 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.

- 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); and
- MnDNR mining features layer (2003) – all areas located within the mining feature area were conservatively assumed to be affected.

The primary area of growth in the watershed is around Colby Lake within the City of Hoyt Lakes.

The major highways that connect the cities within the area include State Highway 135 and County Roads 21, and 110. Several other 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.

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; and

- 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; and
- Proposed Mesabi Nugget Phase II.

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). 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.

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
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 814 wetland acres with the likelihood for an additional 318 acres indirectly impacted by the NorthMet Project; however, even these impacts are small compared to the estimated 33,880 wetland acres currently present in the Partridge River watershed. 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.[39]

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 3.4%. 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 814 acres of direct Project wetland impacts and 318 acres of predicted indirect wetland impacts from the Project.[40]

The mitigation plan as described in Section 4.2.4.2 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.[41]

4.2.5.3 Cumulative Wetland Impacts – Embarrass River

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 Embarrass River Watershed, which is north of the Partridge River watershed, and includes the majority of the Tailings Basin. The consideration of past, present, and reasonable foreseeable actions provides the context for assessing the wetland cumulative impacts within the Embarrass River watershed. This chapter summarizes methods and data from the 2006 Cumulative Wetland Effect Analysis – East Reserve Mining Project prepared by Barr, which analyzed impacts to wetlands in the Embarrass River watershed by the proposed East Mine Reserve Project.

Study Area

The Embarrass River watershed study area covers approximately 180 square miles and extends from the City of Babbitt, Minnesota to the City of Gilbert, Minnesota. Barr (2006) used the MnDNR Census of the Land (MnDNR 1996, *Minnesota Census of the Land*) to identify the primary land uses in the watershed as water, wetlands, forests, brushland, hay/pasture/grassland, mining, and urban development. The latter three of these land cover classes were assumed to be associated with human impacts; therefore, the areas classified with any of these three land cover

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[39] 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.
[40] Tribal cooperating agencies take the position that the impacts to these wetland acres is significant.
[41] Tribal cooperating agencies take the position that 475 acres of required mitigation has not been addressed.

classes were identified as areas in which pre-settlement Trygg wetland data would be used (Trygg 1996).

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); and
- 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, Gilbert, and McKinley, which are experiencing limited growth and development adjacent to existing developed areas. The primary area of growth in the watershed is around the Giants Ridge area of Biwabik.

The major highways that connect the cities within the area include State Highway 135, County Highway 416 and County Highway 21.

Water resources other than wetlands in the watershed include:

- Twenty-eight named lakes, including Embarrass, Hay, and Round in the south and Mud, Hekkilla, Little Birch, and Moose in the north;
- Several water-filled abandoned pits;
- Two large, created wetlands that developed in the LTV Steel Mining Company's reclaimed tailings basin; and
- A number of shallow unnamed waterbodies.

Historical activities within the Embarrass River watershed that have affected wetland resources consist primarily of mining activities, which started in the early 1900s, along with limited urban development. The majority of the watershed has had limited disturbance due to mining, urban development, and agricultural use.

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. Barr (2006) completed the process in four steps, as follows:

1. 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).
2. The areas of the watershed with significant human impact prior to development of the NWI were identified by comparing the Trygg maps with the NWI data.

3. The relationship between the Trygg maps and NWI data was determined for use as an adjustment factor to estimate the acreage of wetlands in areas that have experienced significant human impact.
4. 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.

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 Embarrass 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 Embarrass 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 percent of the land area was classified in the categories associated with human impacts. The areas of human impacted ranged from 0.5 percent to 41.3 percent within the 23 townships. 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 12.8 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

In Barr's 2006 Cumulative Wetland Effect Analysis, wetland areas estimated for the existing conditions were developed by compiling the following data:

- Field wetland delineations completed by Barr. 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, were used to extend Barr's findings to include the NorthMet Project;

- 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 (FSA) 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; and
- 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, mine pit water bodies, and the PolyMet tailings basin wetlands as discussed above. In addition, no NWI wetlands were assumed to be present within the extent of the active Laurentian Mine Pit. 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 Embarrass River watershed were forecasted:

- NorthMet Mine;
- Existing Arcelor Mittal East Reserve Project;
- Proposed resurfacing of State Highway 21; and
- Proposed reconstruction County State Aid Highway 138 from Biwabik to Giants Ridge Road.

The proposed Ispat East Reserve Mining project is expected to directly impact 87 acres of wetlands within the Embarrass River watershed and an additional 29 acres of wetlands within the watershed may be indirectly impacted. The St. Louis Highway connector from Hoyt Lakes to Babbitt currently has several proposed alternative routes under consideration. Wetland impacts would most likely impact approximately 17 acres of the Embarrass River watershed for the preferred alternative. Impacts from alternative routes are currently being evaluated and are unavailable at this time. Resurfacing of State Highway 21 is not anticipated to have any wetland impacts. The proposed reconstruction of approximately 5 miles of County State Aid Highway 138 from Biwabik to Giants Ridge Road would impact 3 to 5 acres of wetlands of the Embarrass River Watershed (Barr 2006).

Results: Cumulative Effects Analysis

Impacts related to past, present, and reasonably foreseeable future actions were evaluated by Barr (Barr 2006) 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 Embarrass River watershed (Table 4.2-10). This analysis did not include the NorthMet Project.

In total, 40,563 acres of pre-settlement wetlands were identified in the watershed, comprising approximately 40 percent of the land area. Existing wetlands and waterbodies comprise 38.9% (39,473 acres) of the land area. This is a decrease of approximately 0.9% land cover (1,090 acres) from pre-settlement conditions, primarily from mining activities, agriculture, and urban and infrastructure development. In total, approximately 18% of the Embarrass River watershed has been impacted by human disturbance.

Table 4.2-10 Embarrass River Watershed Cumulative Wetlands and Deep Water Habitat Analysis Data Summary

Total Pre-Settlement Wetland Acreage	**40,563**
Total Existing Wetland Acreage	**39,473**
Total Future Wetland Acreage	**39,610**
Future Deep Water Habitat (East Mine Reserve)	275

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 Embarrass River watershed would remain in the foreseeable future with or without the NorthMet Project (Table 4.2-10).

Most wetland impacts in the Embarrass River watershed have resulted from past LTVSMC operations, development of recreational areas, including the Giants Ridge Ski Resort, and would result from the East Mine Reserve and NorthMet Projects. The largest wetland impact that has occurred or is proposed to occur is the projected indirect loss of 352 wetland acres by the NorthMet Project; however, even these impacts are small compared to the estimated 39,473 wetland acres currently present in the Embarrass River watershed. 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 wet meadow, black spruce bog/open bog, shallow marsh, and alder thicket/shrub carr. No fens have been identified in the Project area.[42]

The NorthMet Project within the Embarrass River watershed would primarily impact low quality wetlands that are adjacent to the tailings basin. Relative to the 39,473 wetland acres estimated to occur in the Embarrass River watershed (Table 4.2-10), the overall proportion of impacted wetlands from the Project would be about 0.8%. Since most of the impacted wetlands are of low quality the function and values served by the wetlands in the watershed would not be expected to be significantly affected by the approximately 320 acres of predicted indirect wetland impacts from the Project.[43]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[42] 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.

[43] Tribal cooperating agencies take the position that the impacts to these wetland acres is significant.

4.2.5.4 Summary

The mitigation plan as described in Section 4.2.4.2 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 and Embarrass River watersheds and outside the 1854 Ceded Territory.

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. Project effects on several, partially overlapping categories of critical plant species are evaluated: 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.[1]

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).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] It is the tribal cooperating agencies' position that while there is no current documented tribal use of vegetation resources, band members do not always report their harvest sites. Therefore, it should not be assumed that there is no use of resources in these areas. Tribal cooperating agencies also note that the Area of Potential Effect for the Project was not determined until August 11, 2009 and that tribal consultation is ongoing. Therefore, historic and current tribal harvest information has not been determined for either the Plant or Mine Sites.

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: MnDNR 2006, *Gap Land Cover - Vector*

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. The MCBS utilizes a four-tiered ranking system: Outstanding, High, Moderate, and Below (from highest to lowest). The characterization data for the Mine Site is preliminary and has not been finalized by MnDNR. 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 the 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 there may be cause for long-term concern for this community (MnDNR 2009, MnDNR 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 approximately 91 percent of the wetlands were of high quality (Section 4.2).

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 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. “Non-native” species are those species that have been introduced, or moved, by human activities to a location where they do not naturally occur (MnDNR 2009, *Invasive Species*). “Invasive” species are native or non-native species that cause ecological or economic problems (e.g., outcompeting indigenous species or altering the existing ecological community through rapid development of monocultures). 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; Chapman 2007; Larson 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 et al. 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.

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
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 Mine and Plant 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.

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*; at PolyMet Mine Site; MnDNR 2005, NorthMet Mine and Ore Processing Facilities Project Final Scoping Decision Document; 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, *Botrychium Campestre*). This species is among the smallest moonworts and is difficult to observe when occurring 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* (leathery grapefern), 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* 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 of Natural History 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.

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/hydroperiod, 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 the availability of wildlife habitat, which is 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.[2]

Seepage from the north toe of Tailings Basin Cell 2E has the potential to indirectly impact 349.3 acres of wetlands north of the Tailings Basin. There are a total of 546.2 acres of wetlands within the evaluation area north of the Tailings Basin (Figure 4.2-8); however, 196.9 acres were estimated to have incurred previous impacts from the historic seepage from Cell 2W. Essentially all remaining wetlands within this zone of hydrologic modification (349.3 acres) were assumed to be indirectly impacted. 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**

Source: MnDNR 2006, *GAP Land Cover - Vector*

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

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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.

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 by invasive non-native species would reduce the quality of native cover types and habitat remaining at the Project.[3]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] 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.

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[2,4]	84	99	183	46
Mixed pine-hardwood forest	459	544	1,003	46
Mixed hardwood swamp[3]	195	265	460	42
Black spruce forest/bog[3,4,5]	402	441	843	48
Open water	1	2	3	33
Total	**1,454**	**1,562**	**3,016**	**48**

1 Areas of cover types not directly affected by mine pits and stockpiles.

2 Does not 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.

4 Includes the Jack pine – black spruce woodland native plant community (NPC data does not distinguish between the two individual complexes)

5 Includes the 10 acres of wetland impacts from the pipeline corridor

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.[4] The West Pit would remain open water, while the East Pit would support wetland vegetation (see Section 4.2 for further discussion of wetland creation) (Table 4.3-8).

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**

Source: Barr Engineering 2007, RS52.

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).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[4] 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.

Effects of Invasive Non-Native Species

The revegetation plan for Closure at the Mine Site is the same as the Plant Site. Disturbance associated with the construction of the Mine Site would result in exposed surface for potential colonization of invasive species. 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 to the relatively high quality vegetation communities at the 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 State 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 ETSC 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)**	**Total Percent Affected (Populations)**
Botrychium campestre (SC/G3)	1	1	1	0	0	64	unknown	2	0	2
Botrychium pallidum (E/G3)	10	58	8	2	0	68	15	12	3	15
Botrychium rugulosum (T/G3)	1	4	0	1	0	61	14	0	2	2
Botrychium simplex (SC/G5)	24	>1,337	11	13	0	128	25	9	10	19
Caltha natans (E/G5)	5	~150	0	5	0	12	unknown	0	42	42
Eleocharis nitida (T/G4)	13	~1,450 sq. ft.	4	9	0	44	450	9	20	29
Ranunculus lapponicus (SC/G5)	7	~825 sq. ft	3	4	0	65	51	5	6	11
Sparganium glomeratum (SC/G4?)	13	>100	3	10	0	144	82	2	7	9
Torreyochloa pallida (SC/G5)	8	~800 sq.ft	2	0	6	78	unknown	3	0	3
Total	**82**	**NA**	**32**	**44**	**6**	**664**	**NA**	**5**	**7**	**12**

1 The state status is E – Endangered; T – Threatened; and SC – Species of Concern. 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.

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 species 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 water quality impacts, 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, impacts would also occur from 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 right-of-way.

Wetlands comprise the remaining 5.2 acres of vegetation impacts with predominantly lowland shrub communities occurring within the corridor. The capture of Tailings Basin seepage and discharge to the Partridge River would significantly reduce the rate of groundwater seepage from the Tailings Basin to the downgradient wetlands. This reduction in seepage is expected to eliminate any additional indirect wetland impacts north of the Tailings Basin from approximately 349.3 acres under the Proposed Action, to approximately 0 acres under the Tailings Basin Alternative. It is not expected that this diversion of seepage would go so far as converting the existing wetlands to uplands. 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 invasive species, including a revegetation plan identifying the proposed location of the use of native, non-invasive plants. 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 (including noxious weeds) 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 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; and
- Addition of organic amendments to the Tailings Basin – the addition of organic nutrients to the tailings basin would improve sediment and water quality and promote the development of shoreline and near-shore aquatic vegetation.

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, *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife*). 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. 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. 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 (issued by the USFWS or MnDNR to authorize activities resulting in the loss of federal or state-listed species) 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 Essar Steel Minnesota DRI/Steel Plant;
- Proposed Essar Steel Minnesota 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;
- ArcelorMittal East Reserve Project;
- U.S. Steel Keewatin Taconite Mine and plant expansion;
- LTVSMC Mine Closure;
- Community growth and development; and
- Forestry practices on public and private lands.

Exploratory drilling events were not considered indicative of reasonably foreseeable future actions requiring inclusion in this analysis.

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*, 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 coniferous forests	Lowland Coniferous and 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 Lands and Minerals Division 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	24	128	24
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 influence on habitat acreage within the range of these ETSC plant species than does mining and other land development. The acreage affected by forestry 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 with the practice, whereas mining represents a complete land conversion that could affect long-term

ETSC habitat availability. Future timber harvest in the Arrowhead Region from government and private actions may affect over 42,000 acres annually.

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 eight populations and may indirectly impact two more populations. Other projects would directly impact five and indirectly affect two additional populations. In total, approximately 25 percent of the known populations in Minnesota would be directly or indirectly affected by the Project and other reasonably foreseeable 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 campestre is widely distributed across Canada (5 provinces) and the northern United States (15 states). Within the US, *B. campestre* ranges from Washington to New York State and as far south as Colorado. It is listed in four states as endangered (New York), threatened (Michigan), sensitive (Washington) (USDA 2009), or a species of concern (Minnesota) (USFS 2009, *Botrychium campestre*). This species is considered "vulnerable" by NatureServe (NatureServe Explorer 2009). *B. campestre* is relatively uncommon in St. Louis County (3 occurrences) (MnDNR 2009), therefore no other reasonably foreseeable activities are known to impact this species. The prairie/railroad siding habitats in which *B. campestre* occurs are not considered rare or declining in the Laurentian Uplands region. Given that the Project would directly impact one (2 percent) of the 64 known populations statewide, that no other reasonably foreseeable activities would impact the remaining populations, and the potential for the Project to increase the preferred habitat (disturbed) for this species within the Project area, the Project and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. campestre* in Minnesota or 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 10 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 13 populations of the species. Other reasonably foreseeable activities would directly impact four populations and indirectly affect three additional populations. In total, approximately 24 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 percent 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 percent 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.[5]

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,

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[5] It is the tribal cooperating agencies' position that too much emphasis is placed on this species ability to tolerate disturbance. Given that the Project could affect nearly one-third of populations of this species, this could jeopardize the presence of the species in Minnesota.

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.[6]

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 and 11 percent of the known populations of these species, respectively, 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.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[6] It is the tribal cooperating agencies' position that too much emphasis is placed on this species ability to tolerate disturbance.

4.4 WILDLIFE

This 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. Project effects on three, somewhat overlapping, categories of critical wildlife are evaluated: 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.[1]

4.4.1 Existing Conditions

4.4.1.1 Endangered, Threatened, and Special Concern Wildlife Species

Seven federally- and state-listed ETSC wildlife species, which were identified in scoping as potentially present in the Project area are briefly described below. Federally-listed species records are maintained by the USFWS and the state-listed species records are maintained in the Minnesota Natural Heritage Information System (NHIS).

The NHIS is the most complete source of data on Minnesota's rare or otherwise significant wildlife species, but is not a comprehensive statewide inventory. It is based on historical museum records, published information, and field work and is continually updated as new information becomes available. Therefore the lack of a species occurrence in the NHIS database does not necessarily confirm the absence of a particular species in that area (MnDNR 2009,

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] The tribal cooperating agencies note that the Area of Potential Effect for the Project was not determined until August 11, 2009, and consultation under Section 106 of the National Historic Preservation Act is still ongoing between the USACE and 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 MnDNR, the Natural Resources Resarch Institute at the University of Minnesota-Duluth and tribal natural resource management staff indicate that preservation of wetlands may be one of the most important factors in maintaining the moose population in NE MN.

Natural heritage Information System [NHIS]). A county-by-county survey (Minnesot County Biological Survey [MCBS]) of rare natural features is underway. The MCBS is not complete for St. Louis County (including the Plant Site); however, surveys in the vicinity of the Mine Site have been completed (MnDNR 2009, *Minnesota County Biological Survey [MCBS]*). The discussions below include the results of the MCBS at the Mine Site.

Canada Lynx

Canada lynx (*Lynx canadensis*) populations in the United States are protected under the Endangered Species Act (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 lynx are predominantly found in boreal (specifically spruce and fir) forests (USFWS 2009). Mortality due to starvation and declining reproduction rates have been documented during periods of hare scarcity (Poole 1994; Slough and Mowat 1996). 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.

Staples (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; 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; 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 also included 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; RS62, ENSR 2006). Recent research in Minnesota confirmed a resident breeding population of lynx. Of the 426 sightings reported to the Minnesota DNR Division of Ecological Resources between 2000 and 2006, 76 percent were in St. Louis, Lake, and Cook counties. Approximately 113 lynx were sighted in St. Louis County between 2000 and 2006 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 the 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.

The USFS designates Lynx Analysis Units (LAUs) within the Superior National Forest that comprise landscape-scale analysis areas for lynx management. These LAUs were developed in consultation with the U.S. Fish and Wildlife Service. The Mine Site is located within LAU 12; a 70,979-acre area in the southwest portion of the Superior National Forest. According to the USFS (USFS 2009, *MidLevel Tracks Analysis, Wildlife T&E*), approximately 66,414 acres, or 94 percent, of LAU 12 currently provides suitable lynx habitat. The Plant Site is not on USFS land, and therefore is not located within a LAU.

At least 20 different individual lynx sightings have occured 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 Mine or Plant Sites, but DNA analysis of scat indicated 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 for high hare densities as snowshoe hare generally favor sapling or young pole stands (RS62, ENSR 2006). Lynx density may increase as snowshoe hare populations cycle from a low point.

Gray Wolf

On July 1, 2009, a U.S. District Judge signed a settlement agreement that remanded 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 Zone 2 of the designated critical habitat for the gray wolf (43 FR 9607, March 9, 1978). Minnesota is divided into five “zones” with Zones 1, 2, and 3 comprising the critical habitat.

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 has surpassed the federal delisting goal of 1,251 to 1,400 wolves (MnDNR 2008, 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; ENSR 2005; and AECOM 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 representing nests in close proximity and assumed to be used by a single pair (Guinn 2004). No nests were recorded at the Mine and Plant 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 by 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 wood turtle populations, 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 immediately south of the Mine Site and, given its proximity, 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 typically inhabits the coniferous zones 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, the Minnesota NHIS does not contain 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 and 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 identify 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 (ENSR 2005). 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 strategy (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 subsections 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 of 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 Mine and Plant 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
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	1,303
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 Mine and Plant 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 Mine or Plant Sites but not targeted in surveys.

[2] Canada lynx, gray wolf, bald eagle, 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 Mine and Plant 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 surveyed 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 bogs. No wetland SGCN species, however, were observed. marbled godwit, which was surveyed for, was not found likely 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 are 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 surveyed 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 Mine and Plant 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 USFS and PolyMet are currently exploring the feasibility of a land exchange whereby the Project lands would no longer be National Forest lands. The USFS manages 23 RFSS of terrestrial wildlife on this forest. Six 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. Eleven other species are on the SGCN list and are discussed by habitat type in Table 4.4-1. These species include the 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 six species are discussed briefly below.

The northern goshawk (*Accipiter gentilis*) is not federally or state-listed nor is it tracked in the Minnesota NHIS. It is considered globally secure by NatureServe (NatureServe 2009). Its preferred habitat includes older forests, particularly aspen. This habitat is found in the Project area. Recent calling surveys did not identify northern goshawk at the Mine Site (ENSR 2005); however, previous surveys (ENSR 2000) did identify northern goshawk at the Mine Site and the USFS (unpublished data 2009) previously identified a nest site at the Mine Site in 2000. The nest site has not been active since 2000; however, a new stick nest was identified approximately 0.75 mile west of the Mine Site (unpublished data 2009).

The great gray owl (*Strix nebulosa*) is not federally or state-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 great gray owls at the Mine or Plant Sites (ENSR 2000; ENSR 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 federally or state-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 federally or state-listed and is globally secure according to NatureServe (NatureServe 2009). Field surveys for this species were not completed 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 4.2-3), so this species may occur at the Mine Site.

The jutta arctic (*Oeneis jutta ascerta*), a butterfly, is not federally or state-listed and is globally secure according to NatureServe (NatureServe 2009). Field surveys for this species were not completed nor is it tracked in the Minnesota NHIS. However, 749 acres of its preferred habitat (spruce bog) is present at the Mine Site (Table 4.2-3), so this species may occur at the Mine Site.

The Quebec emerald *(Somatochlora brevicincta)*, a dragonfly, is not federally or state-listed, however, it is considered globally vulnerable by NatureServe (NatureServe 2009). Field surveys for this species were not completed nor is it tracked in the Minnesota NHIS. However, the Minnesota Odonata Survey Project (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. There has only been one documented occurrence of this species in Minnesota (Lake County in 2006), although it is not tracked in the Minnesota NHIS. The likelihood of observing Quebec emerald individuals or populations in the vicinity of the Mine Site are low.

4.4.2 Impact Criteria

The following criteria are considered in evaluating Project effects on wildlife:

- Direct effects to federally 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 federally 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; and

- Direct or indirect effects on habitat types that affect population size and long-term viability for federally 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).[2]

4.4.3 Environmental Consequences

4.4.3.1 Proposed Action

Endangered, Threatened, and Special Concern Wildlife Species

Consultation between the USACE and the USFWS regarding the potential effects on federally-listed species is currently ongoing. The USFWS was provided a copy of the PDEIS and no comments have been received. Consultation will continue throughout the EIS process and the results of the consultation process will be included in the FEIS.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] The 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. Consultation with the USACE is currently ongoing.

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 Mine or Plant Sites, but at least 20 different individual lynx were identified within 18 miles of the Mine or Plant 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.[3]

The USFS determined that approximately 4,104 acres, or 6 percent, of LAU 12 is currently unsuitable for lynx use (USFS 2009, *MidLevel Tracks Analysis, Wildlife T&E*). As described above, the Project would result in the loss of an additional 1,454 acres of lynx habitat. The USFS also indicated that current timber harvesting proposals would affect 2,538 acres within LAU 12, although it should be noted that this includes thinning activities, which would not affect lynx habitat, leading to a total of 8,096 acres, or 12 percent of the LAU consists of unsuitable lynx habitat. Based on this analysis, the USFS indicated that no USFS management standards or guidelines would be violated (USFS 2009, *MidLevel Tracks Analysis, Wildlife T&E*).

The increased vehicle traffic associated with the Project, including train and small vehicle traffic between the Mine and Plant 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 Mine and Plant 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 15 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 the stockpiles (Table 4.4-3).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] The 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 Stie might include critical components of lynx habitat present, such as den sites.

Table 4.4-2 Vehicular and Train Traffic Volume Between the Mine and Plant 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/Average				970	4.11	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 (average 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 Closure before suitable lynx habitat would again occur at the Mine Site (RS62, ENSR 2006).[4]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[4] It is the 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.

The impacts to the Canada lynx describe above would result in the localized direct loss and fragmentation of designated critical habitat and the increased potential (albeit low) for incidental takes resulting from vehicular collisions; however, these impacts are not anticipated to threaten the overall species population level and abundance in Minnesota.

Gray Wolf

The Project is located within the designated critical habitat for the gray wolf. Observations indicate the likelihood of a single wolf pack whose territory includes the Mine and Plant 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. Road density outside of the Mine Site would not change as a result of the Project. The haul road network would increase the road density at the Mine Site; however, mining operations would disturb the Mine Site such that it would reduce habitat availability for the gray wolf. Therefore, the haul road network itself would not influence the overall effects of the Project on the gray wolf.

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.

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. Therefore, while the impacts to the gray wolf described above would result in the direct loss and fragmentation of suitable habitat, the increased potential for incidental takes from vehicular collisions, and indirect decline in prey species due to habitat loss, these impacts are not ancitipated to threaten the overall species population level and abundance in Minnesota.

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 Mine or Plant Sites that would provide optimal nesting/foraging habitat. The USFWS eagle management guidelines suggest that human activity within one-quarter mile to two miles can be seen by eagles and, depending on the level of screening and habituation of individual eagles, may cause them to abandon a nest. 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 Mine and Plant 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 Mine and Plant Sites are more than two miles from any known nesting sites and do not provide optimal habitat for nesting and foraging bald eagles.[5]

Wood Turtle

The only known population of wood turtles in the Project area is 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 wood turtle in the area, individuals could potentially use the southern riparian fringe of the Mine Site. These fringe areas would not be permanently impacted by the Project and no wood turtles are currently known occur in the fringe areas that would be affected by temporary Project impacts; therefore, the Project should not have any direct effects on the wood turtle.

The Project would not result in any exceedances of surface water quality standards in the Upper Partridge River; therefore, there would be no significant Project-related changes to water quality

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[5] The 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.

and no indirect effects on downstream habitat where wood turtles are located (refer to Section 4.1.3 for a detailed discussion of Project effects on water quality). Changes in the Upper Partridge River that may affect the wood turtle include increased sedimentation and modifications in the flow regime. PolyMet would provide sedimentation ponds at the Mine Site outlet locations to manage suspended solids prior to discharge, which should be adequate to limit potential sedimentation effects. The predicted small decrease in Upper 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 additional nesting areas. 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. [6]

Heather Vole

The heather vole has not been observed during field surveys within 10 miles of the Mine or Plant 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 (mixed pine-hardwood forest, Jack pine forest, and grassland/brushlands) exists at the Mine Site (Table 4.3-2), 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, Table 4.3-7), but given the lack of known occurrences of heather vole in the Project area, the habitat impacts are 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 the 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 than the reported minimum patch size for nesting, it is not expected to occur at the Mine or Plant Sites. Therefore, the Project is not likely to adversely affect the yellow rail.

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[6] The tribal cooperating agencies have noted concerns in previous drafts of the EIS that the project may create attractive nesting sites were 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.

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 Mine or Plant 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 exploring the feasibility of a land exchange, which would convert Project lands to private ownership and therefore be inaccessible for public use. PolyMet intends to propose private lands within the 1854 Ceded Territory. 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 wildlife species would be displaced. Following migration to new areas, individuals displaced from the Mine and Plant 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. Displaced species may also suffer increased mortality due to foraging in new areas; however, this is unlikely because the habitat at the Mine Site is common to the region. 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 affecting less mobile 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 Mine and Plant Sites, is expected to average approximately 3,989 miles per day with travels speeds averaging between 15 and 45 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 birds.

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 wildlife 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 SGCN 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 habitat type of these areas that would be 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]	611	151
Open Ground, Bare Soils	0	946
Brush/Grassland, Early Successional Forest	245	55
Open Water	1	539
Wetland[2]	597[(3)]	63[(3)]
Multiple Habitats	NA	NA
Total	**1,454**	**1,754**

Source: MnDNR 2009, *GAP Land Cover - Vector*

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.

3 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 19 percent (842 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 is 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 approximately 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 (Table 4.3-8), 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.[7]

Tree plantings would begin to resemble forest habitat types 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 149 acres of removed stockpile areas at the Mine Site that would be re-vegetated with grasses and other herbaceous materials (Table 4.3-8). 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 and Plant Sites consists of small vegetative patches that are generally not attractive to SGCN species. 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

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[7] The tribal cooperating agencies reiterate previous DEIS review statements that single species conifer plantations have little wildlife value.

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, and 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 at the Plant Site after Closure. 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 in Year 65. 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 because of a lack of emergent or submerged vegetation along the pit fringes due to the steep pit walls.

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 surveyed for, but not found (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 1,522.1 acres of wetlands (853.9 acres of direct impacts and 667.9 acres of indirect impacts), primarily coniferous bog (661.7 acres of total impacts) and open bog (189.2 acres of total impacts) (Table 4.2-3). In addition, approximately 349.3 acres of wetlands may be indirectly impacted north of the Tailings Basin, for a total impact of 1,522.1 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.[8]

Some 36,565 acres of wetland habitat exist in the Partridge River watershed surrounding the Mine Site. The wetland types affected at the Mine Site, 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 1,325.5 acres of wetland creation consisting of various habitat types at two sites and an additional 202.3 acres of upland buffer at both sites (Section 4.2.4). 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 and disa alpine) may use the off-site mitigation areas, 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.

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[8] The tribal cooperating agencies stongly 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.

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 effects described 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. Eleven of these species are also on the SGCN list and are discussed by habitat type above. The analysis of potential impacts to the remaining six RFSS of wildlife, which are not federally or state listed ETSC or SGCN species, are discussed below:

- The northern goshawk may be occasionally present at the Mine Site, since an active nest site has been identified approximately 0.75 mile west of the Mine Site. However, their preferred habitat (aspen forest) is common throughout the region and the nest site was not located at the Mine Site. Because the Project would not directly affect the known nest site area and alternative nesting and foraging habitat in the region is common, impacts to the northern goshawk population are expected to be minimal;

- The great gray owl may be occasionally present at the Mine Site, as a nest site has 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 gray 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 age of the forest habitat at the Mine Site is not suitable for three-toed woodpeckers and populations or individuals in the area are not likely to occur. 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 existence 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 and 661 acres would be impacted. 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 existence of this species; and

- The Quebec emerald dragonfly inhabits poor fens, a wetland type not found at the Mine Site but similar to the 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. However, there has only been one documented occurrence of this species in Minnesota (Lake County 2006); therefore, the likelihood of observing Quebec emerald individuals or populations within the vicinity of the Mine Site are low. This species, however, is not considered an ETSC or SGCN species and, therefore, the Project is unlikely to jeopardize the existence 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 under the previous closure agreement 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 and 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 by approximately 33 acres. This alternative would reduce the impacts primarily to Jack pine forest and mixed hardwood swamps and retain these areas for resident wildlife species.

4.4.3.4 Tailings Basin Alternative

The Tailings Basin alternative would reduce the indirect wetland impacts north of the Tailings Basin from approximately 349 acres to zero acres through capture of the seepage from the north toe of the Tailings Basin (see Section 4.2.3.4); however, some of the seepage would be redirected to the Partridge River although no adverse habitat effects are anticipated. This alternative 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 would not be 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 the potential for collisions, and other similar prevention and avoidance techniques.

PolyMet proposes to reclaim disturbed areas as part of 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 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

- Habitat improvements to the West Pit –the West Pit overflow is currently predicted to exceed water quality standards for several parameters (see Section 4.1.3); however, multiple mitigation measures are available which should improve water quality in the West Pit. This improvement in water quality may indirectly benefit some waterfowl species, but for the reasons described above (i.e., steep wall, lack of nearshore vegetation) it is unlikely that the West Pit would provide significant foraging habitat.

4.4.4 Cumulative Effects

Cumulative effects on 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 12.5 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., Emmons and Olivier 2006; Barr 2009, Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species; Superior National Forest Management Plan Revision Final Environmental Impact Statement (USFS 2004b); 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 MnGEIS 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 vegetation types/ecosystems since the 1800s, using recent land cover data from the Minnesota GAP 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 abundance declined significantly , 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 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 Inc. 1994; Friedman et al. 2005). Further, research indicates that current mature forest represents only about 4.4 percent of the old growth acreage that existed in the 1800s (Jaakko Poyry Consulting Inc. 1994).[9]

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 and Jack pine) in northeast Minnesota, although overall harvesting was less than the net growth of forests (MFRC 1999; Jaakko Poyry Consulting Inc. 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, and current timber harvesting practices.

Although there have been changes in forest composition, the Minnesota Forest Resources Council (MFRC 1999; MFRC 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 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 (Lane et al. 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 (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).

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[9] The 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.

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 Resources Inc. 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 Resources Inc. 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 impact" features create physically impenetrable barriers to wildlife including mining pits, in-pit activities, and hardscape such as operations plants and buildings. "Moderate impact" features are 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[1]		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[2] (High/ Moderate)**	**Acres (High/ Moderate)**	**Percent of Habitat Type[2] (High/ Moderate)**	**Acres (High/ Moderate)**	**Percent of Habitat Type (High/ Moderate)**
Open Wetland	6,731	0.7	0.0/50.5	0.0/0.8	7.8/166.8	0.1/2.5	7.8/217.3	0.8/3.2
Lowland Deciduous	17,651	1.7	0.0/0.0	0.0/0.0	73.8/ 485.9	0.4/2.8	73.8/ 485.9	0.4/2.8
Lowland Conifer/Shrubland	187,864	18.7	0.0/278.0	0.0/0.2	381.3/ 3,922.7	0.2/2.1	381.3/ 4,200.7	0.2/2.2
Upland Conifer	67,950	6.8	0.0/48.3	0.0/0.1	257.1/ 2,877.5	0.4/4.2	257.1/ 2,925.8	0.4/4.3
Upland Deciduous (Aspen/Birch)	277,692	27.7	0.0/690.4	0.0/0.3	2,259.2/ 10,923	0.8/3.9	2,259.2/ 11,613.4	0.8/4.2
Upland Deciduous (Hardwoods)	28,680	2.9	0.0/27.4	0.0/0.1	769.8/ 1,099	2.7/3.8	769.8/ 1,126.4	2.7/4.0
Upland Shrub/Woodland	101,459	10.1	0.0/91.1	0.0/0.1	930.3/ 5,326.8	0.9/5.3	930.3/ 5,417.9	0.9/5.3
Water	56,604	5.6	0.0/10.7	0.0/0.0	102.1/ 1,771.2	0.2/3.1	102.1/ 1,718.9	0.2/3.2
Cropland	21,914	2.2	0.0/0.0	0.0/0.0	12.8/ 104.4	0.1/0.5	12.8/104.4	0.1/0.5
Grassland	64,931	6.5	0.0/15.4	0.0/0.0	337.2/ 1,531.7	0.5/2.4	337.2/ 1,546.7	0.5/2.4
Subtotal Vegetated Habitat	**831,476**	**82.9**	**0.0/ 1,211.4**	**0.0/0.2**	**5,131.4/ 28,209**	**0.6/3.4**	**5,131.4/ 29,420.4**	**0.6/3.5**
Urban/Developed	55.440	5.5	0.0/230.5	0.0/0.4	986/ 3,074.2	0.8/5.6	986.0/ 3,304.7	1.7/6.0
Mining-High[3]	37,157	3.7	N/A	N/A	N/A	N/A	N/A	N/A
Mining-Moderate[3]	78,626	7.8	N/A	N/A	N/A	N/A	N/A	N/A
Total	**1,002,699**	**100**	**0.0/ 1,441.9**	**0.0/0.1**	**6,117.4/ 31,283.2**	**0.6/3.1**	**6,117.4/ 32,725.1**	**0.6/3.3**

Source: Barr 2009, *Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species*

1 Urban/Developed Projects are limited to Minnesota Syl Laksin Energy Center, the only reasonably foreseeable non-mining projet identified in Barr 2009 (the Hoyt Lakes to Babbitt Connection project has been cancelled).

2 For percent of habitat type, 0.0 includes occurrences less than 0.01 percent.

3 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 seven Arrowhead counties (Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, and St. Louis) was estimated over the next 20 years for this DEIS using data from the Superior National Forest Revised Management Plan (USDA Forest Service 2004a; USDA Forest Service 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 (high and moderate impacts) total approximately 37,401 acres (Table 4.4-7). This estimate differs from 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 such as bald eagle, Canada lynx, Connecticut Warbler, gray wolf, Least Flycatcher, and Northern Goshawk. 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 31,000 acres over approximately the same period.

In total, approximately 871,000 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., the lack of nutrients and organic material in the soils would slow forest succession). It is assumed that all existing and future mining projects would be required to revegetate disturbed areas as part of their closure plans. Over time, the extent of the 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 been and will likely continue to be mined. The potential for relatively continuous mining operations and/or habitat loss along the Iron 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 (Emmons and Olivier Resources Inc. 2006) and Barr (Barr 2009, *Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species*). The conclusions in the analysis in this DEIS are based on Emmons and Olivier (Emmons and Olivier Resources Inc. 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 (Emmons and Olivier Resources Inc. 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 mile 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 (large 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 (Emmons and Olivier Resources Inc. 2006):

- Essar Steel Minnesota 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 Phases 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 (Emmons and Olivier Resources Inc. 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 Closure may increase the value of the 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 north of the Mine Site and from south and southwest of the corridor. Vegetative restoration of the stockpiles and disturbed areas, as proposed during Closure, would mitigate some of the effects 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 Plant Sites would increase as a result of the Project. This NorthMet transportation corridor is outside of Wildlife 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 effects 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 are not expected to be significant.[10]

4.4.5.3 Wildlife Corridor Impacts by Other Projects

The other reasonably foreseeable projects are anticipated to affect nine of the 13 wildlife travel corridors (Table 4.4-9) identified by Emmons and Olivier (Emmons and Olivier Resources Inc. 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, 8, 10, and 12 (Barr Engineering Corridors 4, 8, 11, 14, 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; however, relative to the impacts from these other reasonably foreseeable projects, the contribution of the NorthMet project to cumulative effects on wildlife corridors would be minor.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[10] The 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.

Table 4.4-9 Cumulative Effects 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 southeast of corridor (<1000 acres). The Project would not physically encroach into the corridor, but mine operations could discourage use during mine operations.
13 (18)	No Impact		Direct Loss	Northshore Peter Mitchell	Possible expansion eastward may block or fragment Corridor 13

Sources: Emmons and Olivier Resources Inc. 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 (Emmons and Olivier Resources Inc. 2006). For comparison purposes, the numbers in parenthesis represent the corresponding corridor numbers in the Barr Engineering study (Barr 2009, *Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species*). NA indicates that this corridor was not identified in the Emmons and Olivier (Emmons and Olivier Resources Inc. 2006).

4.4.5.4 Travel Corridor Mitigation[11]

No wildlife travel corridor mitigation measures are specifically proposed for the Project; however, the following portions of the Project would offset the long-term impacts to the wildlife travel corridors:

- 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), respectively;
- Removal of the rail spurs, buildings and roads, and re-vegetation of disturbed areas during Closure would improve wildlife habitat near the corridors; and
- Closure of operations would reduce human activity and noise levels near the corridors, thereby improving the attractiveness of the area to wildlife.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[11] The tribal cooperating agencies' position is that per Emmons & Olivier (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 wildlife habitat, and impact the ability of many wildlife species to migrate throughout their ranges. Also, until the Section 106 consultation process between the USACOE 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 macro-invertebrates 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

There are no federally-listed threatened or endangered fish or macroinvertebrate species known to occur in the Project area (www.fws.gov/midwest/eco_serv/soc/index.html). The shortjaw cisco (*Coregonus zenithicus*) is informally identified as a species of concern, but not formally listed.

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 to 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 for the Minnesota Waters of Lake Superior*). 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; 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.[1]

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 (Cochran and Pittinelli 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.[2]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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.

[2] 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.

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 (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[(1)]	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
1 River mile indicated for M1 and M2 is measured from the inlet to Colby Lake.

Some of the unionid species known to exist in the St. Louis River basin were not collected by Heath (Heath 2004), including the creeper (*Strophitus undulatus*); plain pocketbook (*Lampsilis cardium*); white heelsplitter (*Lasmigona complanata*); and the black sandshell (*Ligumia recta*) (Table 4.5-1). These creeper, plain pocketbook, and white heelsplitter are typically found in larger streams (Cummins and Mayer 1992) and may exist farther downstream in the drainage system. It is unlikely that the SGCN-designated black sandshell occurs in the Project area given its absence from the sample sites and the lack of its typical habitat (riffles or raceways in gravel or firm sand, Cummins and Mayer 1992).

Other species known to exist in the St. Louis River drainage but also not collected by Heath (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 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% of the substrate at the mussel sample site in the Embarrass River (M-4; Table 4.5-2) (Heath 2004; Breneman 2005). 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.[3]

4.5.1.2 Habitat Conditions and Biotic Assemblages in the Partridge River and Embarrass River

Breneman (Breneman 2005) conducted a biological survey at two sites in the Upper 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 two sites on the Partridge River (B2 and B3) are approximately 20 and 17 miles upstream of Colby Lake, respectively, and both have been previously affected by discharges from the Peter Mitchell Mine. The site on the South Branch Partridge River (B1), identified by Breneman (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 and is unaffected by any mining. The sites in the Embarrass River watershed comprised two wetland sites (B5 and B7) and one stream site (on Trimble Creek, B6), all of which have been affected by seepage from the LTVSMC Tailings Basin. 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 (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.

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[3] 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.

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=submerged 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 (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 at 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 streams of this size and chemical-physical habitat characteristics in this region and are similar to the reference 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

Scientific Name	Common Name	Site					
		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, 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. 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.[4]

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)		
IBI Score	Upper Mississippi River[1] 5-35 mi^2 catchment	St. Croix River[2] <20 mi^2 catchment	St. Croix River[2] 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 Habitat Conditions and Biotic Assemblages in 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 Proposed Action. 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 lakes (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

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[4] 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.

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 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.[5]

Whitewater Reservoir is a mesotrophic water body that encompasses a total surface area of 1,210 acres and a littoral area of 564 acres with a maximum depth of 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 MnDNR for the composition of the fish assemblage in Whitewater Reservoir; however, the composition appears to be similar to what might be expected based upon physical and water quality conditions.[6]

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 and Total Maximum Daily Loads*); however, Colby Lake is listed as impaired with respect to aquatic recreation based on

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[5] The tribal cooperating agencies' position is that if there is data to support this statement, it should be cited in the EIS.
[6] The tribal cooperating agencies' position is that if there is data to support this statement, it should be cited in the EIS.

nutrient/eutrophication biological indicators (MPCA 2008, *Minnesota's Impaired Waters and TMDLs*).

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 (Figure 4.5-3) 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).[7]

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[7] 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 result from alteration of the physical habitat or changes in water quality supporting the aquatic biota. 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. 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. Each of these types and pathways of impact is discussed below.

Physical Habitat Effects

Hydrologic changes are often one of the major sources of impacts to fish and macroinvertebrates. 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.

Partridge River

In the Partridge River, reductions in baseflow (i.e., average 30-day annual low flow) gradually increase during the life of the mine as the mine pits deepen and the drainage area is reduced (i.e., more of the surface runoff is diverted away from the Partridge River to the Tailings Basin or to flood the East Pit), reaching a maximum reduction in Year 20 and then diminishing during Post-Closure when the West Pit floods and overflows. The average reduction in baseflow is the greatest, when measured in terms of percent reduction, at the more upstream locations (e.g., 21% at SW-002, see Figure 4.1-11 and Table 4.1-56) and the impact becomes progressively smaller on a percentage basis with relative position downstream. In most cases, however, the relatively large predicted percent reductions in baseflow involve very small reductions in actual flow (e.g., 0.13 cfs at SW-002). The predicted maximum absolute reduction in baseflow is 0.16 cfs and would occur at SW-004a and continue downstream. The Proposed Action would result in a permanent reduction in base flow of up to 0.13 cfs.

The baseflows in the headwaters of the Partridge River are naturally low to start with (averaging 0.61 cfs at SW-002 under existing conditions for the 10 year period modeled) because of the small drainage area and extensive area of bogs, and the predicted reduction in low flow is so small that it may not be accurately measurable. 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. Late summer monthly flows would be reduced by 3 to 8% during mining depending on location along the Partridge River.[8] As indicated above, the fish community of the Upper Partridge River primarily consists of small insectivores and omnivores such as dace, shiners, and minnows for which a reduction in flow of this magnitude would not likely have an effect, although some species present, especially the dace, could be affected by increases in stream temperature. Certainly the potential effects of this reduction in baseflow and concurrent increases in stream temperature would be biologically insignificant downstream of the confluence with South Branch Partridge River (i.e., Stations SW-004a, SW-005, and USGS gage), where the reductions in baseflow would be only a few percent (i.e., 6% at SW-004a).

Predicted percentage reductions in maximum flows are greatest at SW-004, ranging from -10.1% for 90-day maximum to -12.3% for 1-day maximum under the hypothetical high impact scenario (see Table 4.1-57). 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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[8] 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.

biota.[9] Following filling of the West Pit, however, average monthly flow increases at the more downstream locations (e.g., SW-004a, SW-005, 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.

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 would 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 existing conditions (Table 4.1-59). Under the higher 5,000 gpm withdrawal scenario, average water level in Whitewater Reservoir is 1.00 foot lower than existing conditions. 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, which can affect fish access to shallow water areas for spawning, for example.

The Proposed Action would reduce average flow in the Lower Partridge River by as much as 10.5 cfs as a result of the combined effects of Mine Site activities and water withdrawals from Colby Lake for process water at the Plant Site. This represents about a 9% reduction in average flow in the Lower Partridge River. There would be less of an effect on the magnitude of low flows than average flows, however, because the Water Appropriation Permit requires pumping from Whitewater Reservoir to offset PolyMet withdrawals when water levels in Colby Lake fall below elevation 1,439.0 feet, which equates to a flow of 13 cfs. The net effect of the Proposed Action on flows downstream of Colby Lake would be to reduce average flows and increase the frequency of low flows, but should have minimal effect on the magnitude or frequency of flow releases below elevation 1,439.0 feet. The aquatic community is already accustomed to these low flows, the Proposed Action would not result in any additional impacts.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[9] 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.

Embarrass River

The predicted net increase (relative to existing conditions) in the Tailings Basin seepage contribution to the Embarrass River during operations would be approximately 4.5 cfs during mine operations, representing about a 6% increase in average annual flow. The predicted net decrease (relative to existing conditions) in the Tailings Basin seepage contribution to the Embarrass River during Closure would be approximately 1.1 cfs, representing about a 1% decrease in average annual flow. To the extent this seepage represents a relatively steady contribution independent of weather conditions, it would have a larger effect on minimum flows, temporarily increasing the 30-day average low flow of 9.7 cfs at PM-13 by as much as 46% during mine operations, and potentially reducing it by as much as 11% after Closure. It should be noted that this estimated Closure seepage is approximately the same rate as the existing LTVSMC Tailings Basin would eventually attain once it reaches a steady-state condition. Changes in average annual flow of this magnitude (± 1 to 5%) would be expected to have little effect on the aquatic community in terms of physical habitat or river geomorphology (see Section 4.1.2). The Proposed Action would have no direct surface water discharges to, and would not change the drainage area of, the Embarrass River, but would affect surface hydrology because of seepage from the Tailings Basin. The increase in low flows during mine operation would represent a temporary benefit to the aquatic community, while the decrease in low flows during Closure would be the same as expected under the No-Action Alternative.

Water Quality Effects

The Proposed Action is not predicted to result in any exceedances of surface water chronic standards in the Partridge River, Colby Lake, or the Embarrass River, even under extreme low flow conditions during operations (Table 4.5-10). 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 standards 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).

Table 4.5-10 Predicted Water Quality Compared to Chronic Standards

Parameter	Unit	Class 2B Standard	Upper Partridge River Max. Concentration	Colby Lake Max Concentration	Embarrass River (PM-13) Max. Concentration
Chloride	mg/L	230	8.2	8.2	13.1
Aluminum	µg/L	125	115	76	346
Antimony	µg/L	31	6.9	3.9	5.0
Arsenic	µg/L	53	8.3	5.1	7.6
Cadmium	µg/L	2.5(1)	0.1	0.1	0.4
Cobalt	µg/L	5.0	2.1	0.8	1.6
Copper	µg/L	9.3(1)	7.0	2.5	6.7
Lead	µg/L	3.2(1)	1.1	0.7	1.7
Nickel	µg/L	52(1)	25.6	5.1	14.2
Selenium	µg/L	5.0	1.8		2.6
Thallium	µg/L	0.56	0.40	0.40	0.40
Zinc	µg/L	120(1)	24.6	18	34.5

1 Water quality standard for this metal is hardness-dependent. Listed value reflects a predicted hardness concentration of approximately 100 µg/L.

In Table 4.5-10, aluminum appears to exceed the chronic water quality standard in the Embarrass River (Location PM-13). As discussed in Section 4.1, however, the chronic standard (125 µg/L) applies to dissolved aluminum concentration while the modeled value predicts total aluminum. Aluminum has relatively low solubility in circum-neutral water, so would not be expected to exceed the dissolved standard in the Embarrass River. It should also be noted that existing total aluminum concentrations observed at sampling location PM-13 in 2004, 2006, and 2007 averaged 192 µg/L, with a peak concentration of 433 µg/L and a modeled existing low flow concentration of 671 µg/L.[10] Nevertheless, it is recommended that both surface and groundwater monitoring include both total and dissolved aluminum on a regular basis to ensure that the state chronic surface water quality standard for aluminum is met (see Section 4.1.3.5).

The West Pit is expected to overflow around Year 65 and would flow through an unnamed tributary to the Partridge River. The initial overflow is currently predicted to exceed surface water standards for as many as four parameters (i.e., arsenic, cobalt, nickel, and selenium) in this tributary and possibly in a short reach (approximately 1,000 feet) of the Partridge River. It is expected that the water quality would improve once the pit walls, which are the primary source of several of the contaminants, are submerged. There are several mitigation measures discussed in Section 4.1.3.5 that could be used to treat the pit water before it is discharged and enable it to meet surface water standards.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[10] 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 exceedances of the aluminum aquatic life use criterion will occur.

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 and TMDLs*). Discussion of mercury-related water quality impacts is presented in Section 4.1.2.2 and the potential for the bioaccumulation in fish is discussed in Section 4.5.4.

Therefore, it is not anticipated that changes in water quality as a result of the Proposed Action would result in adverse impacts to fish or macroinvertebrates.

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 existing conditions, although it is expected that the water quality of the Embarrass River may improve as a result of potential corrective actions required by the reissuance of existing NPDES/SDS permits in the Project area.

4.5.3.3 Mine Site Alternative

The Mine Site Alternative is expected to have similar effects on aquatic life as 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, although the Mine Site Alternative is predicted to result in better surface water quality than the Proposed Action. This alternative would have the same effects on the hydrology of the Partridge River, Colby Lake, Whitewater Reservoir, and Embarrass River as the Proposed Action.

4.5.3.4 Tailings Basin Alternative

The Tailings Basin Alternative is expected to have similar effects on the hydrology and water quality of the Upper Partridge River as the Proposed Action. It would, however, affect the hydrology and water quality of Colby Lake, the Lower Partridge River, and the Embarrass River as a result of discharging seepage captured by the vertical wells to the Partridge River downstream of Colby Lake. These effects are described below.

Physical Habitat Effects

Partridge River

The Tailings Basin Alternative – Maximum Recycle Option would significantly reduce the need for water withdrawals from Colby Lake from an average of 3,500 gpm to an average of approximately 800 gpm (Barr 2009, *Technical Memorandum: TB-14 Plant Site Groundwater Impacts Predictions*). 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.

The Tailings Basin Alternative would still reduce flow in the Lower Partridge River (3.4 cfs for the Maximum Recycle Option and 5.3 cfs for the No Recycle Option), but by less than the Proposed Action (-10.5 cfs). Given the average flow in the Lowe Partridge River immediately downstream of Colby Lake is approximately 116.6 cfs, the net reduction in flow from the two Tailings Basin Alternative options would represent a small percentage of average flow (3 to 4%). Under low flow conditions, the MnDNR Water Appropriation Permit would still require maintenance of critical water levels in Colby Lake and minimum flows downstream. Under the Tailings Basin Alternative, these low flows should occur less often relative to the Proposed Action.

In summary, the Tailings Basin Alternative would reduce water level fluctuations and maintain higher flows in the Lower Partridge River relative to the Proposed Action, which should benefit the aquatic community by increasing available habitat.

Embarrass River

The two Tailings Basin Alternative options would reduce flow in the Embarrass River by 1.7 cfs (during operations) to 1.9 cfs (during Closure), but this reduction is small relative to average flow in the Embarrass River of 85.5 cfs (as estimated at location PM-13). The reduction in flow would be more significant during low flow periods (30-day low flow at location PM-13 is estimated as 9.7 cfs). To the extent that much of this groundwater 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 groundwater baseflow contribution to the Embarrass River.

Water Quality Effects

Similar to the Proposed Action, the Tailings Basin Alternative is not predicted to result in any exceedances of surface water chronic standards in the Partridge River, Colby Lake, or the Embarrass River, even under extreme low flow conditions. The Tailings Basin Alternative, however, 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 have been defined by MPCA as “high risk” situations for potential methylmercury formation. As a result, this alternative is expected to reduce the risk of methylmercury forming and therefore would reduce the risk of methylmercury impacts on aquatic life as compared to the Proposed Action.

Although discharge of pumped seepage would increase sulfate loadings to the Lower Partridge River, there are few riparian wetlands and no downstream lakes, which are the locations that most methylmercury formation is believed to occur. This alternative is expected to meet all surface water chronic 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 and Monitoring Measures

Section 3.2.2 describes potential mitigation and monitoring measures that could address the various impacts from the Proposed Action and alternatives identified in this DEIS. None of these specifically address effects fish and macroinvertebrates, but many of the recommendations would improve water quality. The Tailings Basin Alternative incorporates several of these measures that would reduce impacts to the physical habitat of the Lower Partridge River from the Proposed Action.

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 incomplete 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 Wynne, Sabin, Embarrass, and Esquagama Lakes (through which the Embarrass River flows); Colby Lake and Whitewater Reservoir in the Partridge River watershed; and segments of the St. Louis River (MPCA 2006, *Minnesota's Impaired Waters and Total Maximum Daily Loads*) (Figure 4.5-4). 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, *Minnesota's Impaired Waters and Total Maximum Daily Loads*) 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% of the mercury deposition in northern Minnesota is emitted from Minnesota-based sources (Jackson et al. 2000).

The remaining 90% is evenly divided among other North American sources, global sources, and natural background emissions (Engstrom and Swain 1997; MPCA 2005, *Mercury Reduction Progress Report to the Minnesota Legislature*; 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.

4.5.4.3 Project-related Effects

Mercury deposition from the atmosphere is the primary source of mercury at the Project site. An evaluation was conducted on the potential deposition of mercury related to the Plant Site air emissions. This evaluation assessed the Project's potential effects on mercury concentrations in fish tissue and the potential health risks to a hypothetical recreational and subsistence fisher consuming those locally-caught fish. Two emission scenarios were evaluated. In one scenario, it was assumed that 80% of the mercury would be in the elemental form, 10% in oxidized form, and 10% particle bound (RS38A, Barr 2007). In the second scenario, it was assumed that 25% of the mercury would be in the elemental form, 50% in oxidized form, and 25% particle bound. The second emissions scenario is considered a worst-case estimate because wet scrubbers on the Hydrometallurgical Plant would be expected to capture most of the particle-bound and oxidized mercury and the majority of the mercury would likely be elemental (RS38A, Barr 2007).

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. MMREM incremental risk quotients below 1.0 are not expected to yield significant impacts. For the worst case emissions scenario (50% oxidized mercury), the estimated maximum potential incremental increase in mercury concentrations in the fish is 0.015 parts per million (ppm), which is an order of magnitude lower than the mercury background concentrations estimated for Heikkilla Lake (0.65 ppm). The Heikkilla Lake mercury background concentration results in a background risk quotient above 1.0 without any incremental increase from the Project. These estimates of background quotients are a common occurrence in Minnesota lakes. The Project's projected incremental risk quotient for a recreational or subsistence fisher is 0.07 and 0.34, respectively. These risks are below the incremental risk guideline level of 1.0; therefore, no significant impacts are expected from potential mercury deposition from the Project.

In addition to atmospheric contributions of mercury, local factors related to Project construction and operation have the potential to affect mercury bioaccumulation, either through mobilization of mercury stored in rock, soil, peat and vegetation on site, or through factors that may enhance the methylation of mercury. These factors include:

- The availability (or non-availability) of mercury resulting from the Project;
- Mobilization of sulfate resulting from the Project;
- Hydrologic changes and water fluctuations;

- Land cover changes, including forest clearing; and
- Peatland disruption, including stockpiling and subsequent decomposition of organic matter from wetlands.

The role that each of these factors plays in methylmercury production is discussed in Section 4.1. In general, the Project is not expected to result in a significant direct release of inorganic mercury to waterbodies because both Duluth Complex rock and LTVSMC/NorthMet tailings have been shown to sequester mercury. The primary concern related to mercury for the NorthMet Project is the potential for releasing increased sulfate loads, which could promote mercury methylation (Figure 4.5-5).

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 edible fish tissue (>95%), however, is accumulated as organic mercury (Bloom 1992). Thus, methylation is a key step in bioaccumulation of mercury in fish. Methylmercury is a product of inorganic mercury reduction by sulfate-reducing bacteria, a process that can be stimulated by increased sulfate concentrations in aquatic systems where sulfate is limiting (Gilmour et al. 1992; Krabbenhoft et al. 1998).

The Proposed Action would result in seepage with relatively high sulfate concentrations from the Tailings Basin that would exceed the aquifer flux capacity, so much of the groundwater 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 favorable 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. Therefore, increasing the sulfate load from the Tailings Basin could increase the potential for mercury methylation.

The MPCA has established a strategy for addressing the effects of sulfate on methylmercury production, which focuses on avoiding “discharges,” which could include groundwater seepage, to “high risk” situations, such as wetlands, low-sulfate waters (<40 mg/L) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria, and downstream lakes that may stratify, all of which apply to the area downstream of the Tailings Basin. Therefore, the Proposed Action would result in the release of sulfate to a high risk situation for mercury methylation.

It should be noted, however, that the predicted sulfate concentrations in the Tailings Basin during operation and Closure are similar to existing sulfate concentrations from LTVSMC seepage, but limited monitoring near the Embarrass River (e.g., PM-13) found lower methylmercury concentrations than at an upstream location with much lower sulfate concentrations. This suggests that sulfate is not promoting significant mercury methylation, perhaps because existing sulfate concentrations may be sufficiently high that sulfate is not the limiting factor. This sulfate could, however, still promote mercury methylation downstream in the chain of lakes. PolyMet is conducting additional sampling in wetlands, streams, and downstream lakes under a MPCA approved plan to help better understand mercury relationships in the Project area.

The Tailings Basin Alternative was designed to avoid these "high risk" situations by capturing Tailings Basin seepage with vertical wells and discharging it to the Partridge River, thereby avoiding the wetlands and lakes downstream from the Tailings Basin.

The analyses described above 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. An increase in mercury loadings, especially methylmercury, to the Embarrass River would make attainment of mercury standards more challenging. The Proposed Action would result in the release of sulfate to areas that MPCA considers "high risk" for mercury methylation within the Embarrass River watershed. Ongoing monitoring should help determine if these areas are in fact producing methylmercury. The St. Louis River has relatively few riparian wetlands and no lakes, at least in its middle segment between the confluence with the Embarrass River (RM 139) and Knife Falls Dam (RM 35.5). Therefore, the Project is not expected to contribute significantly to mercury in the St. Louis River.

The Mine Site Alternative would be expected to have similar effects on mercury as the Proposed Action. The Tailings Basin Alternative would avoid these high risk areas by capturing the seepage and discharging it to the Partridge River downstream of Colby Lake, which avoids most wetlands and lakes that stratify[11].

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[11] 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. 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. 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 permitable 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 (NOAA 2009).

Based upon surface data taken at Hibbing Monitoring Station, predominant winds are from the north-northwest through west-northwest approximately 25% of the year (Figure 4.6-1). Winds from the south-southeast through southeast show a secondary predominance, occurring approximately 15% 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 µg/m^3	Primary and Secondary	Not to be exceeded.
Ozone	8-Hour	0.075 ppm	147 µg/m^3	Primary and Secondary	Daily maximum 8-hour average
Lead	Quarterly		0.15 µg/m^3	Primary and Secondary	Rolling 3-month Average
Total Suspended Particulate (TSP)(2)	Annual Geometric Mean		75 µg/m^3 60 µg/m^3	Primary Secondary	Not to be exceeded.
	24-Hour		260 µg/m^3 150 ug/m^3	Primary Secondary	Not to be exceeded more than once per year
PM_{10}	Annual Arithmetic Mean(2)		50 µg/m^3	Primary and Secondary	Not to be exceeded.
	24-Hour		150 µg/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 µg/m^3	Primary and Secondary	Not to exceed the 3-year average of the weighted annual mean concentrations
	24-Hour		35 µg/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/m^3 60 ug/m^3	Primary Secondary(2)	Not to be exceeded.
	24-Hour	0.14 ppm	365 µg/m^3	Primary and Secondary	Not to be exceeded more than once per year
	3-Hour	0.5 ppm	1300 µg/m^3	Primary and Secondary	
	3-Hour(2)	0.35 ppm	915 µg/m^3	Secondary	
	1-Hour(2)	0.5 ppm	1300 µg/m^3	Primary	
Hydrogen Sulfide(2)	½-Hour	0.05 ppm	70 µg/m^3	Primary	Not to be exceeded over 2 times per year
	½-Hour	0.03 ppm	42 µg/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	36 μg/m^3	75 μg/m^3 60 μg/m^3	Primary Secondary	Virginia City Hall
	24-Hour	101 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	5.9 μg/m^3	15 μg/m^3	Primary and Secondary	Virginia City Hall
	24-Hour	20 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, *Annual Air Monitoring Network Plan*

(1) Minnesota State Ambient Air Quality Standard only.

(2) The USEPA revoked the annual PM_{10} standard (effective December 17, 2006). However, it is still reflected in the State of Minnesota's regulations.

(3) Secondary standard for Air Quality Control Regions 128, 131, and 133.

(4) 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 is considered to be a "nonattainment area" for that pollutant and the State is 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 they are in compliance or that 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), which may include flora/fauna, visibility, water quality, soils, and odor for a Specific Class I Area. 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 applicable 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 would 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 expand or shorten depending on the final assessment of the permit application 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 rules, *Minnesota Rules* part 6132.800, administered by the MnDNR, require the control of dust from areas disturbed specifically by mining operations.

Also, the MPCA has promulgated rules concerning the control and permitting of all sources (not just for mining operations) 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 (i.e. to be permitted as a synthetic minor source). 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 proposed in the Final SDD.

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 2007, Draft-02; RS58B, Barr 2007).

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 expand or shorten, 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, and limits SO_2 emissions to 0.5 pounds per million British Thermal Units (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 or 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%.
- 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%. 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%. 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%. 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%. Alternatively, due to the remote location of the Project, compliance can be demonstrated with a pollution control equipment efficiency of 85%. 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 Proposed Action 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

Detailed air dispersion modeling was conducted to evaluate compliance with NAAQS and MAAQS, to conduct PSD increment analysis, and to review other 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 are also discussed[1].

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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 at the Plant Site, resulting in a 60% reduction in emissions, except that more controls would be undertaken on the roads used to transport construction materials at the Tailings Basin under the Proposed Action, resulting in an 80% reduction in emissions.

Detailed information on 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 specifically listed source category. The Project is not included in any of the listed source categories, therefore fugitive sources are not included in the determination of a major source.

Table 4.6-5 Annual Point Source Criteria Air Pollutant Emissions (tons/year)

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
TSP	185	8	193	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 (tons/year)

Pollutant	Plant Site Projected Actual Emissions	Mine Site Projected Actual Emissions	Total Projected Actual Emissions
NO_x	0	315	315
SO_2	0	10	10
PM_{10}	122	685	807
$PM_{2.5}$ [(1)]	15	101	116

(1) Source: Barr 2009, *PolyMet - Hoyt Lakes Minnesota, Summary of Emission Data.*

$PM_{2.5}$ 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. On May 16 2008, the USEPA published the *Final Rule for Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$)*, which required Minnesota to implement changes into their PSD program by July 15, 2008. As part of the rule, states are allowed to defer regulating condensible fraction of $PM_{2.5}$ until either USEPA has completed an assessment of test methods or January 1, 2011. However, the MPCA requires that $PM_{2.5}$ condensibles be counted as emissions for PSD applicability and emission limits. Therefore, for the purposes of this DEIS, $PM_{2.5}$ (filterable and condensible) have been estimated and modeled.

Due to these recent changes, PolyMet has recently developed analyses to address the $PM_{2.5}$ emissions and impacts, which are included in this DEIS.

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 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)	Major Source Threshold (tpy)
Single HAP(1)	5	1	6	10
Combined HAPs	14	5	19	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 4.6-7 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 assuming 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 for the Mine Site only, since these emissions were primarily fugitive particulates (Barr 2007, *Dispersion Modeling Protocol, Addendum*). 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 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}, $PM_{2.5}$, 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 ozone is not emitted directly from any mining or ore-processing source. Emissions of lead were not modeled because the Project would not result in appreciable lead emissions. Carbon monoxide emissions were not modeled due to the likelihood, as determined by the MPCA, that there would not be any concerns related to the outcome of the modeling for this pollutant.

The SIA was determined for pollutants that 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 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. Model inputs for LTVSMC were taken from previous modeling conducted for LTVSMC. 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. $PM_{2.5}$ background concentrations represent the 2006-2008 average concentrations for the highest 2^{nd} high (H2H) 24-hour and annual average concentrations from the same station. SO_2 and NO_x background concentrations are from 2008 MPCA update data for use in modeling assessments (MPCA 2008, *Annual Air Monitoring Network Plan for the State of Minnesota*) for sites outside Minneapolis.

Class I Area-Related Modeling Approach

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 USEPA long-range transport modeling methodologies, and followed guidance as presented in USEPA'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 USFS 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 (Barr 2008, Class I Air Dispersion Modeling). The CALPUFF modeling analysis used the 5^{th} Generation NCAR/Penn State Mesoscale Model (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 the CALMET subprogram of CALPUFF 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.

Updated Modeling Assessment of Class I AQRV Impacts at 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. Based upon review by the FLM and the MPCA on the previous modeling, the four-kilometer and one-kilometer spacing modeling grids predicted essentially equivalent results, thus, the two agencies approved the use of the four kilometer grid in the subsequent modeling analysis.

NAAQS and PSD Increment Impact Analysis

State and federal air quality rules prohibit emissions from a new facility that cause or contribute to an exceedance of MAAQS or NAAQS. In addition, impacts from Project emissions were compared to established PSD increments. To demonstrate Project impacts compared to 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 Report for the NorthMet Project Mine Site,* Barr 2008, *Class II Air Dispersion Modeling Report for the NorthMet Project Plant Site*), which has been fully evaluated for the DEIS.

It should be noted that the fully evaluated modeling analysis to date was conducted prior to the latest revision to the Project Description 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 96 tons/year and 11 tons/year, respectively. These represent a 19% increase in PM_{10} emissions and 5% increase in $PM_{2.5}$ emissions at the Plant Site. Based solely upon the increase in emissions, impact conclusions for PM emissions are not expected to change from those identified in this section, except for two scenarios. The exceptions are 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% of the standard. An analysis of these two scenarios has recently been completed, but has not been evaluated by the MPCA. The results of the most recent analysis have been included in this DEIS, but should be considered preliminary (Barr 2009, Technical Memorandum: *Preliminary Modeling Results for Tailings Basin Proposed Action*). This modeling analysis will be evaluated more completely in the Final EIS.

The Plant Site PM_{10} emissions were modeled with all sources operating at full capacity in a single modeling run. This conservatively (overestimates) predicts the impact as not all sources would be capable of operating simultaneously at full capacity. PM_{10} and $PM_{2.5}$ are the primary pollutant emitted from the Plant Site. Emissions of SO_2 and NO_X would be relatively small 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 mining rate of 32,000 tons of ore.

The primary emission generating activities at the Plant and Mine Sites are located 8 miles apart from each 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. A portion of this railway is proposed to be used for the transportation of ore from the Mine Site to the Plant Site. Although the site may be permitted as a single facility, there is a significant distance between the Plant and Mine Site emission sources. Therefore, it is appropriate and informative to perform individual air dispersion modeling for two distinct sets of receptors, one set surrounding the Mine Site area and the second surrounding the Plant Site area. For the Mine Site receptor grid, both Mine Site and Plant Site emissions were modeled explicitly. However, for the Plant Site receptor grid, only the emissions from the Plant Site were included since previous modeling of the Mine Site emissions showed that impacts were below the Significant Impact Level (SIL) in the region encompassing the Plant Site receptor grid. 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. The MPCA approved the exclusion of the Mine Site emissions in assessing the impacts at the Plant Site receptor grid locations as they would not likely contribute to a change in the overall impacts. The results are discussed below.

Table 4.6-8 shows modeled impacts at the Plant and Mine Site receptors compared to the SIL. 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% capacity for each averaging period.

The overall impacts within the Plant Site receptor grid predicted higher maximum concentrations than the impacts within the Mine Site receptor grid for all pollutant modeled. As seen in the table, maximum NO_2, PM_{10}, and $PM_{2.5}$ concentrations in both regions (and for all averaging periods) were above their appropriate SILs and further analysis in those regions was conducted. For SO_2, the impacts in the Plant Site receptor grid exceed their SILs for all averaging periods and additional analysis was conducted for this receptor region. The SO_2 impacts in the Mine Site receptor grid are all below each respective SIL, and thus, no additional analysis was conducted.

Table 4.6-8 Highest Project Impacts and PSD Class II SILs

Pollutant	Averaging Time	PSD Class II Significant Impact Limits (ug/m^3)	Plant Site Area Modeled Impacts (ug/m^3) (1)	Mine Site Area Modeled Impacts (ug/m^3) (1)
SO_2	3-hour	25	**147**	2.1
	24-hour	5	**37**	0.61
	Annual	2	**5**	0.04
PM_{10}	24-hour	5	**56**	**29**
	Annual	1	**11**	**4.9**
$PM_{2.5}$	24-hour	5(2)	**14**	**13**
	Annual	1(2)	**5**	**3**
NO_2	Annual	1	**9**	**1.9**

(1) Bold Values exceed SIL
(2) Final SILs have not been promulgated by USEPA.

PSD Class II Increment Analysis

Based upon the results of the SIL analysis, PSD Class II Increment analyses were completed for PM_{10} and NO_2 for both the Plant and Mine Sites receptor grid locations. In addition, a PSD Class II Increment analysis was conducted for SO_2 only at the Plant Site receptor region. It should be noted that even though maximum $PM_{2.5}$ concentrations exceed the SILs, the USEPA has not set a baseline date for increment analysis to date. Therefore, no increment analysis can be conducted for this pollutant. However, modeling of $PM_{2.5}$ will be conducted for comparison with the revised 2008 $PM_{2.5}$ NAAQS, later in this section. 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.

The table displays the maximum predicted concentrations for each pollutant of concern and each averaging period for both the Plant Site and Mine Site receptor grid locations. Since the receptor grid locations for the Plant Site and Mine Site represent separate distinct regions, the maximum modeled impact for each modeling region is compared separately with the PSD Class II Increment limit to assess potential significant impacts. Overall, all modeled impacts are below their respective PSD Class II impacts, however, the maximum 24-hour PM_{10} impacts in the Mine Site modeling region approaches the Class II Increment (29 mg/m^3 versus 30 mg/m^3).

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 would be 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 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 25 ug/m^3 on the Plant Site boundary receptor grid, based on the 24-hour H2H modeling. Modeled impacts for SO_2 and NO_X at the Plant Site receptors are 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 satisfy 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.

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	25	29	30
	Annual	-0.5[(1)]	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.
(1) Negative predicted concentration is a net result of the shutdown of the former 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 (i.e., NO_X, SO_2, PM_{10}, and $PM_{2.5}$).

Table 4.6-10 below summarizes results of the NAAQS model analysis for Mine Site and Plant Site separately. 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 the entire Project and nearby sources. The highest 6th high (H6H) PM_{10} concentration for the five-year modeling period was used for comparison to the NAAQS PM_{10} 24-hour standard, which allows one exceedence per year. 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 highest 8th high (H8H) $PM_{2.5}$ concentration for the five-year modeling period was used for comparison to the NAAQS $PM_{2.5}$ 24-hour standard (the average 98th percentile over a three-year period). $PM_{2.5}$ background concentrations represent the 2006-2008 average concentrations from the 98th percentile 24-hour concentration and annual average concentration from the air quality monitoring site data in Virginia, Minnesota.

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 Report for the NorthMet Project Mine Site*, Barr 2008, *Class II Air Dispersion Modeling Report for the NorthMet Project Plant Site*; Barr 2009, Technical Memorandum – *Preliminary Modeling Results for Tailings Basin Proposed Action*).

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. 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.

The maximum impacts from the Mine Site analysis are slightly lower for all pollutants than the impacts from the Plant Site summarized below. The maximum predicted 24-hour PM_{10} concentration (Mine Site contribution plus background) was 84 ug/m^3, approximately 55% of the corresponding NAAQS. The maximum predicted 24-hour $PM_{2.5}$ concentration of 30 ug/m3 is approximately 86% of the short-term $PM_{2.5}$ standard. All other predicted concentrations are at or below 60% of the allowable levels, which demonstrate compliance with all MAAQS and NAAQS.

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 and unpaved road emissions. The maximum 24-hour PM_{10} modeled impact of 86 ug/m^3 occurred along the Plant Site southern boundary (Figure 4.6-3). Similarly, the maximum 24-hour $PM_{2.5}$ modeled impacts was predicted to be 34 ug/m^3 near the same area (see Figure 4.6-4). All predicted concentrations are below allowable levels and the results demonstrate compliance with all MAAQS and NAAQS.

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	21	293	1300
	3-hour	147	N/A	10	157	915
	24-hour	37	N/A	4	41	365
	Annual	5	N/A	2	7	60
PM_{10}	24-hour	86	52	32	118	150
	Annual	23	7	15	38	50$^{(1)}$
$PM_{2.5}$ $^{(2)}$	24-hour	17	13	17	34	35
	Annual	6	3	6	12	15
NO_X	Annual	9	2	6	15	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 exceedance 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 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 Proposed Action 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% (a potentially detectable change) and 10% (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 maximum change in light extinction for the VNP and IRNP are below the 5% threshold with values predicted at 4.5% and 1.2% change, respectively. The maximum change in light extinction at the BWCAW for the three years modeled is predicted to be 14.7%. The data in Table 4.6-12 indicate that calculated visibility impacts greater than 5 or 10% could occur at some point within the BWCAW on a small number of days each year. 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% 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

A culpability study has been conducted for the impacts presented in Table 4.6-12. Based upon the modeling reported in a 2009 summary (Barr 2009, *Summary of Class I Modeling*), approximately 34% of the worst-case day impacts were associated with haul trucks at the mine site and an additional 21% associated with the space heaters at the Plant Site, both primarily due to NO_x emissions. In addition, approximately 10% was associated with other diesel mining equipment and 9% of the worst-case day impact was contributed from the locomotive engines. 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

Deposition of Nitrogen and Sulfur

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 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 0.01% 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% 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	3.0	3.0	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 for sulfur and one-fifth of the nitrogen 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	Aquatic 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) the same criteria were applied to VNP and IRNP, which is administered by the NPS but do not have published standards 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 Air Dispersion Modeling Report for NorthMet, Addendum 01*), Class I area annual 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

This section includes the assessment of potential human health impacts for the Project. Separate Air Emissions Risk Assessments (AERAs) were conducted for the Plant Site region and the Mine Site region due to the large distances (approximately 10 kilometers) between the Plant Site sources and the Mine Site.

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 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).

Table 4.6-16 Chemicals for Evaluation of the Incremental Human Health Risk Assessment for the Plant Site

Chemical	CAS Number	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], [b]		
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.

[b] There are inhalation toxicity values for Chromium (VI), but not for Chromium (III). In the absence of speciated Chromium (VI), total chromium is screened using the Chromium (VI) inhalation toxicity value. In this assessment, there were speciated pilot test data for Chromium (VI) and this data set was used in the AERA.

Air dispersion modeling was conducted to assess the potential for exposure to 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.

Initially, a screening level human health risk is conducted where all CFE maximum concentrations are assumed to occur at the same location. A refinement to the risk assessment is the calculation of maximal potential health effect impacts based upon both space and time. That is, when the health effect impacts are calculated for all pollutants at each receptor and meteorological condition modeled. The results of the Plant Site assessment demonstrate that the chronic additional lifetime cancer and noncarcinogenic impacts were below guidance levels and the acute noncarcinogenic health effects were also below the guidance level, when adjusted for locational differences as described above (RS38A, Barr 2007).

The maximum exposed individual (MEI) multi-pathway additional lifetime cancer risk at the former LTVSMC ambient air boundary 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 level value of 1 E -5. Similarly, the reasonable maximum exposed off-site worker (RME-OSW) inhalation additional lifetime cancer risk at the Project boundary was predicted at 3 E -6, also below the MDH additional lifetime cancer risk guidance level. The major risk drivers for these estimated cancer endpoints were nickel, arsenic, and cadmium compounds.

The non-cancer chronic MEI multi-pathway hazard index (HI) for the farmers and residences were each calculated to be 0.19, primarily from the potential 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) and compared to a general guidance value for chronic HI as 1.0. Thus, the potential health impacts for both farmer and residences assessed under the MEI concept are approximately 20% of the chronic guidance level. The chronic HI for the RME-OSW receptor was predicted to be 0.45, which is still half of the chronic guidance level.

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 level of 1.0. This screening value sums all 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 the various locations of the maximum modeled annual average air concentration for risk driver pollutants (i.e., risk driver pollutant concentrations differ in space), the maximum acute MEI HI was reduced to 0.9, below the acute guidance level.

It should be noted that this analysis, in part, was based upon a PM_{10} emission rate of 481 tpy from the Tailings Basin.[2] From the revision of the Project after the submittal of RS38A (Barr 2007), as described in Section 3, the toxic compounds from fugitive emissions are based upon a PM_{10} 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 potentially for manganese, beryllium, cadmium, and antimony. Cadmium and antimony are included in this discussion, although the content of the LVSMC tailings was below analytical detection limits (the content was assumed equivalent to one-half the detection limit for the purposes of this analysis). These four compounds were not drivers in the original risk assessment (May 2005) or in the March 2007 analysis (RS38A).

A conservative assessment was conducted to assess the upper-limit change in health effects from the change in tailings concentrations for these for pollutants. Assuming that the additional lifetime 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 additional lifetime carcinogenic risk (and hazard index) for each pollutant to estimate the maximum change. The results indicated that the overall additional lifetime 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 additional lifetime cancer risk guidance level. 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 guidance level.

Estimations of additional lifetime cancer risk were conducted for both the maximum exposed individual (MEI) and the 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 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).

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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.

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 for the Mine Site

Chemical[1]	**CAS Number**	**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 of RS38B

Estimations of additional lifetime risk were conducted for the MEI concept for both residential and farmer receptors. As stated earlier, the MEI represents a worst-case screening assessment that is designed to represent the upper-limit bounds of potential incremental additional lifetime cancer risk and assumes a continuous outdoor exposure of 24 hours per day, 365 days per year, for a period of 70 years.

Similar to the Plant Site AERA, air dispersion modeling was conducted for the Mine Site to assess the potential for exposure of potential receptors to 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 additional lifetime cancer and noncarcinogenic impacts from direct exposure (inhalation) at the Mine Site property boundary were below guidance levels and the acute noncarcinogenic inhalation health effects were also below the guidance level (RS38B, Barr 2008). The maximum inhalation pathway MEI additional lifetime 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 guidance level of 1.0.

The MEI multi-pathway (direct + indirect) cancer risk estimated was estimated to be 3 E -5 for farmers using the Mining/Industrial District boundary. This is above the MDH additional lifetime cancer risk guidance level of 1 E -5. The major risk drivers were due to indirect exposure (including ingestion of milk and beef produced and the ingestion from home grown crops) of dioxins, indeno(1,2,3-d,e)pyrene, and dibenzo(a,h)anthrezene potentially associated with diesel fuel combustion in mine vehicles. It should be noted that RS38B (Barr 2008) provides additional discussion on the conservatism in these emission estimates. It should be further noted that maximum multi-pathway additional lifetime cancer risk is located at the Mining/Industrial District boundary. The nearest small farms are located approximately 6.5 miles from the Mine Site. 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.[3] Thus, the MEI residential risk due to direct exposure (inhalation only) would be representative at the Mining/Industrial District

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] 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 exceedance 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.

boundary (6 E -7). Furthermore, the inhalation additional lifetime cancer risk at the Mine Site boundary is also below the MDH guidance value as noted above.

The MEI multi-pathway additional lifetime cancer risk for a hypothetical nearby resident at the Mining/Industrial District boundary was 7 E -7, which is below the MDH guidance value of 1 E -5. The major risk drivers for cancer endpoints for this receptor were nickel compounds, arsenic compounds, and dioxins.

Greenhouse Gases

The science, policy and regulatory framework regarding greenhouse gases are continually evolving and often subject to differing interpretation. For the purposes of the DEIS, the effort in presenting the information below was intended to provide the current understanding through September 16, 2009 and subsequent information regarding climate change will be updated in the FEIS.

According to the Intergovernmental Panel on Climate Change (IPCC), evidence has lead the IPCC scientists to conclude there is a high likelihood 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 (IPCC 2007, Climate Change 2007: The Physical Science Basis). It is estimated that 40% of a pulse emission of CO_2 remains in the atmosphere for approximately 100 years. Approximately 15-30% of the emissions are expected to remain after 1,000 years and approximately 10-15% are expected to remain after 10,000 years. The estimated mean lifetime of emitted fossil CO_2 is between 30,000 and 50,000 years (Archer, 2005). As such, the atmospheric greenhouse gas levels are likely to continue to rise over the next few decades. The body of evidence has lead scientists to conclude with 90% certainty that higher levels of atmospheric greenhouse gas tend to warm the planet. Globally, an "unequivocal" warming of 1.3°F (plus or minus 0.3°F) occurred between 1905 and 2005 (IPCC 2007, Climate Change 2007: The Physical Science Basis). Other data have shown 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. 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.

Climate changes can involve changes in temperature and changes in 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 emissions scenarios, using an ensemble of results from multiple global climate models (GCMs), suggest an increase in annual precipitation of 10-15% over the next 70 to 90 years in the Great Lakes Region (USGCRP 2009), although regional results from these models are more uncertain than global results. The current modeling also suggests that winter and spring precipitation will increase 20-25%; summer rainfall declines 5-10% in the model results.

Although the degree of impact is uncertain, particularly when analyzed at the regional and local levels, water resources could be affected by the climate change patterns. Due to increased temperature, evaporation would 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.

If Minnesota's climate becomes drier, forest areas near the prairie-forest border could be replaced with grassland ecosystems (Frelich and Reich 2009). Minnesota's forested areas could decrease by 50-70% (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 would 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 that includes wetland losses in some area and wetland gains in other areas.

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 emission reports to USEPA. The gases covered by the proposed greenhouse gas emissions reporting rule are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hodrofluorocarbons (HFCs), perfluorcarbons (PFCs), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). The proposed rule would require the first annual greenhouse gas emission report to be submitted on March 31, 2011, for 2010 emissions.

In response to the 2007 United States Supreme Court ruling in *Massachusetts v. EPA*, 549 U.S. 497 (2007), the USEPA Administrator signed a Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the CAA on April 17, 2009. 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 national cap-and-trade program for greenhouse gas emissions. The House has approved a version of the bill and the Senate is debating greenhouse gas legislation.

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, Wisconsin, and the Province of Manitoba, Canada) to long-term greenhouse gas reduction targets of 60-80% below 2005 emission levels as part of the Midwestern Greenhouse Gas Reduction Accord in 2007. 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 directing that interim reduction recommendations be developed, including a 15% reduction target for 2015 and a 30% reduction target for 2025, which could be in effect during the lifetime of this project. The interim goals are designed as milestones toward meeting the state's goal of reducing greenhouse gas emissions to a level at least 80% 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 of 2007.

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 under the MEPA for certain projects that require stationary source air emissions permits. In July 2008, MPCA issued the *General Guidance for Carbon Footprint Development in Environmental Review*. A carbon footprint analysis (e.g., greenhouse gas inventory) is required of any proposed facility that needs to complete and Environmental Assessment Worksheet (EAW) and requires an Air Permit. In the same month, a second guidance document was issued, *Greenhouse Gas Evaluation Guidance,* which requires an energy and greenhouse efficiency analysis. This is required only of those facilities with a potential to emit (criteria pollutants) of greater than 100 tons or those facilities that need an Air Emissions Risk Analysis (AERA).

After water vapor, CO_2 is the second-most abundant greenhouse gas and would be the primary greenhouse gas 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 predicted from the Project are a result of combustion emissions from the various processes. No HFC, PFC, or SF_6 emissions are expected from the Project.

CO_2 emissions would be emitted from activities directly affected by the Project, as well as other indirect activities. Direct emissions from the project would result from combustion of fossil fuels in the Mine Site and Plant Site equipment, exhaust of mobile equipment at both sites, and emissions from process equipment at the Plant Site. In addition, secondary emissions from the change in the existing land cover are projected. CO_2 emissions from carbon stock loss (i.e., wetland vegetation, trees, and peat) due to the excavation of wetland and deforesting of the project area, as well as the loss in CO_2 sequestration from the affected land cover disturbances of the wetlands, forests, and peat storage would occur, although sequestration estimates from wetlands are more uncertain due to difficulty in quantifying methane emissions..

Indirect emissions would occur as a result of Project activities, however, the emission sources are not in the Project's control. For the NorthMet Project, indirect emissions would result from the electrical needs that would be met with offsite power supply. CO_2 emissions from the power plants supplying the power are included for this project. Table 4.6-18 summarize the direct and indirect CO_2 emissions from the proposed project. Emission estimates are tabulated in metric tons of CO_2-equivalents (CO_2-e m.t./yr), which account for the varying compound-specific global warming potentials. As seen from the table, the project overall emissions were estimated at approximately 776,650 CO_2-e m.t./yr, of which approximately 35% occur directly from the Project-related activities.

Table 4.6-18 Summary of the Annualized Carbon Footprint for the Proposed NorthMet Project

Emission Type	CO_2 Emissions (CO_2-e m.t/yr) [(1)]		Percentage of Total	
Direct Emissions				
Mine Site				
Stationary Combustion	4,940		0.6	
Mobile Combustion Sources	37,049		4.8	
Total Mine Site Direct Emissions	*41,989*		*5.5*	
Plant Site				
Stationary Combustion	93,306		12.2	
Stationary Non-Combustion	100,041		13.0	
Mobile Combustion Sources	312		<0.1	
Total Plant Site Direct Emissions	*193,659*		*25.2*	
Secondary Sources				
Wetland, Peatland, and Forestland Clearance[(2)]	23,000		3.0	
Total Secondary Emissions	*23,000*		*3.0*	
Total Direct Emissions		***258,648***		*33.7*
Indirect Emissions				
Power Purchases	509,000		66.3	
Total Indirect Emissions		***509,000***		*66.3*
Total Facility Emissions		**767,648**		**100.0**

(1) Units = Greenhouse Gas Emissions as CO_2-equivalents in metric tons per year.
(2) Emissions include emissions from carbon stock loss and sequestration capacity.

It is estimated that the Project equipment would potentially directly emit 235,248 metric tons of CO_2-equivalent emissions (41,989 metric tons from the Mine Site and 193,659 metric tons from the Plant Site) or 0.24 million metric tons per year. Emissions from wetland, peatland, and forestland clearance, as well as, sequestration capacity loss, accounts for an additional 23,000 metric tons of CO_2-equivalent emissions (0.02 million metric tons per year). Potential indirect greenhouse gas emissions, primarily related to power production for the Project are estimated at

509,000 metric tons of CO_2-equivilent emissions (0.51 million metric tons per year) (Barr 2009, *NorthMet Project Greenhouse Gas and Climate Change Evaluation Report*).[4]

For this analysis, emission estimates for the direct and indirect source equipment used generally accepted emission factors and estimation methods from the World Resource Institute Greenhouse Gas Protocol Standard, the IPCC, and the MPCA General Guidance on Carbon Footprint in Environmental Review. Emissions estimates from secondary emissions generally utilized emissions factors that would represent estimates greater than actual values (high estimation) or best estimates of actual values based upon literature review (central tendency (Barr 2009, *NorthMet Project Greenhouse Gas and Climate Change Evaluation Report*).

The potential impact of the NorthMet Project is evaluated only based on emissions of greenhouse gases from the project on its own and in combination with offsite emission generation. There are not analytical or modeling tools to reliably evaluate the incremental impact of a project's discrete greenhouse gas emissions on the global and regional climate. In addition, there are no analytical and modeling tools to reliably evaluate any cascading impacts, cumulative effects, from a particular project's greenhouse gas emissions on natural ecosystems and human economic systems in a given state or region. However, the Project would increase the CO_2 emissions in the atmosphere. In addition, impacts to wetlands, forests, and other cover types are likely to affect carbon storage and sequestration in these ecosystems. Although a quantitative assessment of the impacts could not be conducted, proposed reclamation and mitigation activities described below can offset some of the carbon losses caused by Project.

Greenhouse gas reduction measures

PolyMet's plans to improve both energy and production efficiency to reduce greenhouse gases associated with the Project (Barr 2009, *NorthMet Project Greenhouse Gas and Climate Change Evaluation Report*). 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 proposes a hydrometallurgical process rather than a pyrometallurgical process which would result in reduced in energy usage. The use of the hydrometallurgical process is expected to reduce the Project's energy demand by 50% over comparable pyrometallurgical processes. However, while energy use is reduced by one-half, greenhouse gas emissions do not decline per unit of production from what would be expected from a pyrometallurgical process, principally because of the large load of non-energy process emissions associated with hydro processing.

In addition, PolyMet proposes to use premium efficiency motors rather than standard motors. Motor efficiencies typically vary between 85% and 96%, depending upon the size and load of the motor. Gravity transport of process slurries would also be used where possible, instead of pumps. PolyMet proposes to configure the Process Plant such that the overall power factor for

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[4] 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.

the facility is as close to one (energy input to energy output) as practical, which would help minimize electricity use.

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. PolyMet would purchase new Gen-Set locomotives, which are more efficient and use less fuel than conventional locomotives. 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. Of the three feasible options, electric heating, propane-fired heating, and natural gas-fired heating, natural gas-fired heating generates approximately 82% fewer CO2-equivalent emissions than electric heating and 66% fewer emissions than propane-fired heaters.

PolyMet evaluated additional methods to reduce the Project's greenhouse gas emissions, but found the additional methods infeasible (Barr 2009, *NorthMet Project Greenhouse Gas and Climate Change Evaluation Report*). The methods evaluated included electric drive mine haul trucks, electric locomotives, newer mill technology, flotation alternatives, 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 implement a wetland mitigation plan (see Section 4.2 of this DEIS) 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 would primarily take place 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 4:1 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) would contribute to compensating for the Project's impacts on Type 8 wetlands.[5]

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5 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 from the Plant Site. 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 lbs/year. Most of the remaining estimated mercury emissions (0.4 lbs/year) are from natural gas used to fuel a package boiler and for space heating. Less than 0.1 lbs/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% 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[6].

The low percentage of estimated mercury release to the air is primarily because the oxidizing conditions in the autoclave would likely cause most of the mercury that is released from the concentrate into the exhaust gas 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 to the air would be expected to be in the elemental (Hg^0) form. Detailed calculations for all Process Plant emission units are provided in RS57A (Barr 2008, *Stationary Point and Fugitive Source Emission Calculations for the NorthMet Project Plant Site*).

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 (RS38A, Barr 2007). The Mine Site AERA did not assess potential local mercury deposition because potential emissions are less than 1.0 lb/yr (RS38B, 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% of the mercury would be in the elemental form, 10% in oxidized form, and 10% particle bound (RS38A, Barr 2007). In the second scenario, it was assumed that 25% of the mercury would be in the elemental form, 50% in oxidized form, and 25% 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 (RS38A, Barr 2007).

For the worst case emissions scenario (50% oxidized mercury), the analysis estimated that the maximum potential incremental increase in mercury concentrations in the fish is 0.015 ppm,

[6] 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.

which is an order of magnitude lower than the mercury background concentrations estimated for Heikkilla Lake (0.65 ppm). The Heikkilla Lake mercury background concentration results in a background risk quotient above 1.0 without any incremental increase from the project, a common occurrence in Minnesota lakes. 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 0.34, respectively. These risks are below the 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, June 2009, and August 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 employ best available control on mercury emitting sources. If best controls reduce emissions by less than 90%, the new source will be subject to periodic review for opportunities for improved control efficiency;
- Conduct environmental analysis for project and cumulative impacts
- Provide an assessment of whether its added emissions will impede progress in attaining the sector goal, if applicable, or the statewide goal if the new source is not in an existing sector;
- New or expanding facilities expecting to emit more than 3 lb/year (after application of best controls) will arrange for a reduction equal to the new emissions from existing sources in the state. These equivalent reductions must be beyond those otherwise required in the state's mercury emission reduction plan for existing sources. Equivalent reduction can also be accomplished by reducing emissions ahead of the schedule established in the state's Implementation Plan;
- If equivalent mercury reductions from other facilities with Minnesota can not be identified, an alternative mitigation strategy may be proposed in lieu of the in-state emission reduction requirements. Alternative mitigation strategies will demonstrate an environmental benefit related to mercury and will be consistent with the objectives of the TMDL. Alternative mitigation strategies may include air emission reductions from sources located outside of the state;
- Submit a plan to the MPCA describing the facility's specific plan for reductions described above.

PolyMet would 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 additional 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 possible 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 potential use of lime or limestone have been shown to be minimal (Barr 2008, *ALT07 – Technical Memorandum: Emission Estimates for Stockpile Lim/Limestone Addition*).

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 135,516,400 ton-miles/year in Year 16 (Barr undated, Comparison of Modeled Years for Proposed Project). The maximum annual haul truck ton-miles from this alternative is estimated at 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 (Barr 2008, *Technical Memorandum: Potential Air Quality Impacts from NorthMet Tailings Basin Design Changes*). 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

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, which is also presented in this section.

- ***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% could occur at some point within the BWCAW on a small number of days each year (a maximum of 23 days per year above 5% and one day above 10% – see 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% of the worst-case day impacts. In order to minimize the impacts from locomotive emissions, PolyMet has already proposed to replace the existing LTVSMC locomotives with gen-set units (having multiple diesel engines in a single locomotive engaging and dis-engaging automatically as required) that would meet USEPA Tier-III emission requirements as a viable mitigation measure for this Project. The use of the gen-set locomotives would result in improved fuel efficiency (compared to traditional single diesel engine locomoties) as well as reduced emissions versus the older locomotives, 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 they 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. Energy conversion of natural gas combustion to heat energy is approximately 80% versus only 30% 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 if electric heating were used, and therefore, switching to electric heating 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% 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 FLMs to evaluate additional potential control measures that may be applicable to the Project. Currently, mitigation options exist that are being considered and could be evaluated in the Final EIS. The investigation is expected to be completed during the permitting process with MPCA and the FLMs[7].

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

- ***Fugitive dust control and mercury deposition minimization and mitigation strategy:*** 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. 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 would be specified in the fugitive dust control plan that would be submitted to MPCA for approval. This plan would be an enforceable requirement of the air permit.

  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 plants to be the most effective in controlling fine particulate matter emissions. PolyMet has agreed to upgrade the particulate matter controls on crushing plant sources to baghouses. This means than 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 lbs/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 lbs/year of the mercury originally contained in the ore. In addition, some mercury would 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 small amount (0.02 lbs/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

[7] 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.

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 would be described in the fugitive dust control plan, which would be submitted for MPCA approval. This plan would be an enforceable requirement of the air permit.

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 5% of the mercury in the concentrate would be released into the air from the autoclaves, in part because elemental mercury (Hg) in a pressurized oxygen environment at low pH would oxidize forming Hg^{2+}. This would then complex with anions, such as sulfate (SO_4^{2-}) and chloride (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 would tend to partition to the solid and liquid components of the slurry material. Mercury emitted in vapor and steam emissions from the process would mostly be present as Hg^{2+}. Wet pollution control devices effectively control this type of mercury.

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 (RS32, Part 4, Barr 2008), 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 gas phase. 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 oxidized 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 to 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 would 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/yr 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. PolyMet would be required to submit a specific mercury emission control plan to meet the requirements of the guidelines and the Project would not be permitted until a verifiable plan can be approved by the MPCA.

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 would 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 would 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 the use of 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 (lb/yr).

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 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.

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 4.6.3.1. However, relative to NAAQS, MAAQS, and PSD Class II Increments, the receptor 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 effects 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 was conducted by adding the maximum impacts from the Project to the maximum impacts from the recently conducted cumulative analysis prepared for the Minnesota Steel EIS, in order to assess overall impacts. The following sections describe the results of the assessments.

4.6.4.1 Cumulative Ambient Air Quality Effects (NAAQS/MAAQS)

As stated earlier, an assessment at the Plant Site was conducted using the same modeling approach as presented in Section 4.6.2.1 with the exception that receptor locations were limited to the former LTVSMC facility boundary or beyond. Figure 4.6-2 shows the former ambient air boundary for the former LTVSMC site. The cumulative analysis included potential emissions for all NorthMet Project sources and from nearby source 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 is also a "cumulative impacts" analysis because the modeling considers other nearby sources (Mesabi Nugget, Cliffs Erie Pellet Yard, Peter Mitchell Mines, and the Plant Site).[8]

Table 4.6-19 below summarizes results of the cumulative NAAQS model analysis. The H6H 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. The $PM_{2.5}$ background concentrations represent the 2006-2008 H2H 24-hour and annual average concentrations from the same site. None of the cumulative NAAQS model results exceed NAAQS and MAAQS.[9] It should also be noted that the cumulative modeling analysis shows the maximum concentrations reported in Table 4.6-19 are primarily due to impacts from Syl Laskin Energy Center. Impacts for which the NorthMet Project alone would be directly culpable are lower.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

8 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.

9 The Tribal cooperating agencies' position is that this analysis is incomplete and that the 24-hour PM2.5 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 PM2.5 NAAQS standard.

Table 4.6-19 Results of Cumulative Class II NAAQS Modeling

Pollutant	Averaging Time	Maximum Modeled Concentration (ug/m³)	Background (ug/m³)	Total (ug/m³)	NAAQS and MAAQS (ug/m³)
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	8	17	25	35
	Annual	2	6	8	15
NO_X	Annual	3	12	15	100

(1) The annual NAAQS for PM10 was rescinded on October 17, 2006.

4.6.4.2 Cumulative Class II Increment Effects

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 effects modeling. The results of the increment analyses are shown in Table 4.6-20, along with a comparison to the allowable Class II PSD increments.

The data in Table 4.6-20 summarize the PSD Class II Increment modeling results and demonstrate that the Project, in conjunction with all other neighboring PSD sources, would satisfy all state and federal increment limits.

Table 4.6-20 Results of Cumulative Class II PSD Increment Analysis

Pollutant	Averaging Time	Cumulative Modeled Concentrations (ug/m³)	PSD Increment Limits (ug/m³)
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:
Plant Site modeled cumulative emissions include Plant Site, Mesabi Nugget, Cliffs Erie Pellet Yard, and LTVSMC.

4.6.4.3 Cumulative Class I Increment Effects

Based upon the analysis presented in Section 4.6.3.1, the only Class I analysis that was above 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 4.6-21 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.[10] This analysis may also indicate that there is little increment left for future Projects.

Table 4.6-21 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 Effects below.

4.6.4.4 Cumulative Effects of Acid Deposition on Ecosystems

The potential for cumulative effects 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 to the air 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_x and 2,340 tons per year SO_2, if all were constructed and operated (RS69, Barr 2007). This represents approximately a 12% and 6% increase in the estimated emissions for the two

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

10 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.

pollutants in the four county "zone of interest" for 2004 (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 1,950 tpy and -2,360 tpy for NO_2 and SO_2 respectively, since 2000 (RTS69, Barr 2006, Draft-02). 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, 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 increased amounts of 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 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 4.6-22 summarizes the emission increases due to the nine new foreseeable Projects (RS70 Addendum 01, Barr 2007).[11]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

11 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 4.6-22 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 lb/yr is used. If the average of 61 lb/yr 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 USEPA 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% (MPCA 2009, Technical Support Document).

(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 lb/yr 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 2006, *Review of Minnesota Power's AREA Project*). 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 lb/yr. Taconite emissions were 551 pounds in 1985, while recent emissions have been averaging approximately 670 pounds (Table 4.6-23).

Table 4.6-23 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 RS69.

(4) Future emission reductions in the study area are listed in Table 1 of Section 1.1of RS69.

(5) The TMDL goal is to reduce Minnesota mercury emissions to approximately 789 lb/yr. Based on the estimated "Total" emissions of 2,332 lb/yr, an additional reduction of 1,543 lb/yr (a 66% reduction) will be needed to meet the TMDL goal.

The USEPA is now developing a maximum achievable control technology standard for electric power boilers to control mercury. The standard is expected to be proposed by 2012.

In the period of time between the completion of the cumulative effects analysis background study for 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 develop a plan to identify and employ best controls to reduce mercury emissions by at least 90% and if the facility's emissions are greater than 3 lb/year after controls, must seek equivalent emission reductions within the state. PolyMet would therefore need to prepare a MPCA-acceptable plan as part of the permitting process.

4.6.4.6 Cumulative Visibility Effects

A cumulative effects analysis assessing the potential visibility effects on Federal Class I areas was performed to provide information for the NorthMet Project EIS (RS71, Barr 2006). Also, in addition to the quantitative assessment of cumulative PM_{10} increment consumption in the BWCAW described in Section 4.6.4.3, a semi-quantitative assessment of potential cumulative PM_{10} air concentrations and the potential effect on increment consumption in Minnesota Class I areas was also completed (RS37, Barr 2006).

Cumulative Effects Analysis – Class I Visibility

To help determine the potential effects on visibility impairment in the Class I areas in Minnesota from the Project when combined with all other concurrent projects, a cumulative effects analysis for visibility was performed by PolyMet. The semi-quantitative analysis took into account the Proposed Project along with other projects that were recently permitted or are currently in the permitting or environmental review process. The results of the analysis were described in a technical report – *Cumulative Impacts Analysis Minnesota Iron Range Industrial Development Projects; Assessment of Potential Visibility Impacts in Federal Class I Areas in Minnesota* (hereafter called the '2006 Visibility Class I Study'). An addendum to this report was also submitted in 2007 (RS70 Addendum 1, Barr 2007). The 2006 Visibility Class I Study addresses the impacts from the Proposed Project and all other past and "reasonably foreseeable" proposed projects consistent with the Scoping Decision Document (SDD). This analysis focused on a four-county project area (Itasca, St. Louis, Lake, and Cook Counties).

The analysis presented here represents an update to the study previously prepared for the Project (RS71, Barr 2006). The updated analysis presented here includes a six-county project area (two additional counties added: Koochiching and Carlton), additional projects and updated information on some projects included in the 2006 study (RS71, Barr 2006). These updates were incorporated to make the analysis consistent with the work done in Minnesota to address the federal Regional Haze Rule since the 2006 Visibility Class I Study was submitted to the state agencies.

4.6.4.7 Background on the Regional Haze Rule

The USEPA published regulations in July 1999 intended to improve visibility in the nation's Class I areas. On June 15, 2005, USEPA issued final amendments to the July 1999 rule. This rule and amendments are referred to as the Regional Haze Rule. Minnesota has two Class I areas – the Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park. In addition, emissions from Minnesota contribute to visibility impairment to Michigan's Isle Royale National Park Class I area. The rule requires that by Year 2064 visibility in the Class I areas reflect no man-made impairment and also requires the installation of Best Available Retrofit Technology (BART) emission controls that reduce visibility impairment, for certain industrial facilities emitting air pollutants. The MPCA must submit a State Implementation Plan (SIP) to USEPA that describes a 2018 visibility goal that makes reasonable progress towards the ultimate 2064 goal. Minnesota's Regional Haze SIP outlines the 2018 visibility goal and includes a target for 30% reduction in combined NOx and SO2 emissions by 2018 from 2002 levels from point sources in Northeast Minnesota that emit over 100 tons per year of either NOx and SO2.

Minnesota's Draft Regional Haze SIP (MPCA 2008, Minnesota Draft Haze SIP – FLM Review Copy) relied on implementation of the Federal Clean Air Interstate Rule (CAIR) to substitute for BART for power plants and in predictions of future emissions. CAIR was vacated by the DC Circuit Court of Appeals, in July 2008, but on re-hearing the Court decided simply to remand the rule to USEPA. As one of the issues raised was whether Minnesota should be included in the CAIR region, USEPA has indicated that it intends to stay the effectiveness of CAIR in Minnesota. In the revised 2009 Draft Regional Haze SIP, MPCA included BART determinations for affected power plants for which it had previously relied on CAIR to reduce emissions.

Summary of the 2006 Visibility Class I Study Scope (Updated in 2009) – Background

Regional Haze and Visibility Impairment

The USEPA (USEPA 2003, Guidance for Tracking Progress Under the Regional Haze Rule) defines "regional haze" as visibility impairment caused by the cumulative air pollutant emissions from numerous sources over a wide geographic area. The primary pollutants that are contributing to regional haze in Minnesota's Class I areas are anthropogenic emissions of fine particulate matter ($PM_{2.5}$). $PM_{2.5}$ includes ammonium sulfate, ammonium nitrate and organic carbon matter (MPCA, 2008, *Annual Air Monitoring Network Plan*). Each of these components can be naturally occurring or the result of human activity. The natural levels of these species result in some level of visibility impairment in the absence of any human influences, and will vary with season, daily meteorology, and geography (USEPA 2003, *Guidance for Estimating Natural Visibility Condition Under the Regional Haze Rule*).

There are two categories of fine particulates: primary and secondary. Fine particulates, 2.5 microns or less in diameter, that are placed directly into the atmosphere are called primary particulates. Secondary particulates are formed as a secondary pollutant by the chemical transformation of NO_x, SO_2, or VOC. Secondary particulates are the main contributor to regional haze. Both categories of fine particulates (primary and secondary) can be transported long distances.

Coarse particles between 2.5 and 10 microns in diameter do contribute to light extinction. However, these particles tend to settle out from the air more rapidly than fine particles and can be found relatively close to their emission sources (USEPA 2004, The Particle Pollution Report; MPCA 2005, *Annual Pollution Report to the Legislature*), so emissions from the Project in this size range are not likely to impact Class I areas.

<u>Measuring Visibility</u>

Visibility is characterized by the light extinction coefficient and haze index. Additional description on these two measures of visibility is provided below.

Light Extinction Coefficient

The light extinction coefficient is the sum of the atmospheric concentration of each species of interest multiplied by a corresponding coefficient. The light extinction coefficient is referred to as b_{ext} and has units of 10^{-6} m^{-1} or $(10^6\ m)^{-1}$, or as typically labeled, inverse megameters (Mm^{-1}). Data from the IMPROVE network is used to calculate light extinction coefficients for those Class I areas where monitoring is conducted.

Haze Index (Deciview)

The haze index or deciview (dv) was developed to address the issue that light extinction coefficients are non-linear with respect to human perception of visual changes. The deciview is derived from calculated light extinction, and is designed such that uniform changes in haze correspond approximately to uniform incremental changes in perception, across the entire range of conditions, from pristine to highly impaired (40 CFR Part 51.301).

Visibility Impairment “Cumulative Impact” Approach

The scope of the updated cumulative effects on visibility for the Project was completed in essentially four general steps:

1. Assess the Interagency Monitoring of Protected Visual Environments (IMPROVE) data for Voyageurs National Park and the Boundary Waters Canoe Area to provide the current status of particulate air concentrations and haze index including a trends analysis where there is sufficient data. PM_{10} concentrations are used to assess particulate concentration trends.
2. Assess available information from the Regional Haze State SIP that identifies emission sources and/or emission source regions as significant contributors to ambient air concentrations in the Class I areas located in Minnesota.
3. Evaluate local, statewide and national SO_2, NO_x, and PM_{10} emissions and trends using existing emission inventory data.
4. Evaluate the cumulative effects from the proposed projects based on the potential increases in SO_2, NO_x, and PM_{10} emissions and concurrent reductions from current and reasonably foreseeable projects and the expected decrease in state and national emissions.

Analysis Boundaries

The following boundaries were identified to define the extent of the analysis for the visibility cumulative effects study:

1. The timeframe for the trends analysis, both past and future.
   - The timeframe for this analysis is 1990 to 2035.
2. Other “reasonably foreseeable” actions to be assessed in addition to the Proposed Project.
   - The following projects and actions are considered to be underway or “reasonably foreseeable”:
     - Proposed Projects:
       - Excelsior Energy, Mesaba Energy Project, Coal Gasification Power Plant
       - Laurentian, Wood Fired Energy Project
       - Mesabi Nugget Company, Direct Reduced Iron (DRI) Plant

- Mesabi Nugget Company, Phase II Project
- Essar Steel (formerly Minnesota Steel Industries), Mining/Taconite/DRI/Steel Plant
- Northshore Mining Company, Furnace 5 Reactivation Project
- PolyMet Mining, NorthMet Project
- SAPPI Cloquet Plant Expansion
- UPM/Blandin Paper Mill Expansion, Project Thunderhawk
- U.S. Steel Keetac Expansion Project

- Emission Reduction Projects
  - Minnesota Power Taconite Harbor Energy Center Unit 2, Emission Control Modifications
  - Minnesota Power Laskin Energy Center Unit 2, NO_x Reductions
  - Minnesota Power Boswell Energy Center Unit 3
  - U. S. Steel Minntac BACT Reductions
  - United Taconite Green Production Project
  - Xcel Energy's Metro Emissions Reduction Project and Sherco reduction projects
- Regulatory and other actions:
  - Implementation of the Regional Haze Rule and BART Rule;
  - Implementation of the CAIR Rule or NO_x SIP call (40 CFR parts 51, 72, 75, 96)
  - Implementation of the Taconite MACT
  - USEPA Proposed Rule for NO_x in Class I Areas (Fed. Register, Vol. 70, No. 35)
  - State acid rain rule and statewide SO_2 emissions cap
  - Title IV of the 1990 Clean Air Act Amendments.

3. The geographic area that may be affected (the "zone of impact").
   - The "zone of impact" is defined as the area of concern to be evaluated for potential cumulative effects due to the above listed actions. Based on the scope defined in the SDD for the Proposed Project, the selected zone of impact is defined as Voyageurs National Park and the BWCAW. Voyageurs National Park is primarily located in St. Louis County, while the BWCAW encompasses parts of St. Louis, Lake, and Cook Counties.

Assessment of Existing Conditions

An assessment of the baseline visibility conditions for Minnesota's Class I areas is based on monitoring data from the IMPROVE program. Monitor sites from both the BWCAW (monitor ID: BOWA1) and Voyageurs National Park (monitor ID: VOYA2) were included in the analysis. The IMPROVE website (http://vista.cira.colostate.edu/improve/Default/htm) along with the Visibility Information Exchange Web System (VIEWS) (http://vista.cira.colostate.edu/views/Web/Data/DataWizard.aspx), provide ambient air concentrations for particulate speciated by chemical and relative humidity data. The VIEWS website provides the total light extinction coefficient from aerosol measurements and relative humidity.

The data for the BOWA1 location indicates a downward trend for haze index from 1992 to 2006 for the 20% best days, 20% worst days and the median days. The data for VOYA2, representing a shorter time period from 2000 to 2006, did not show a trend for either improving or degrading haze index.

Natural, local, state, national and international emission sources contribute to visibility impairment in Minnesota's Class I areas. Minnesota's Regional Haze SIP recognizes that international pollution is a contributor to visibility impairment in Minnesota's Class I areas.

The Regional Haze SIP includes a modeling analysis of the potential contributions to light extinction for ammonium sulfate and ammonium nitrate on the 20% worst days by Minnesota and surrounding states for the projection year 2018 for BWCAW and Voyageurs National Park. The analysis indicates that Minnesota is the single largest contributor to visibility impairment at approximately 30%. The remaining 70% of the estimated contribution is from surrounding states such as Iowa, Illinois, Wisconsin, and other areas. Northeast Minnesota sources make up approximately 50% of the contribution of visibility impairment coming from Minnesota (MPCA, 2008) or about 15% of the total from all sources.

Environmental Consequences

Summary of Emission Trends

Table 4.6-24 shows the estimated potential emissions of SO_2, NO_x, and PM_{10} from each of the proposed projects included in this analysis. Concurrent emission reductions are provided for comparison to the emissions estimated for the proposed projects. Proposed projects were included only if they were not operating for most of 2006. This cutoff date was chosen since the monitoring and emission inventory data used to assess the past or existing conditions includes information up to 2006. Any sources not operating during most of 2006 were not included in the analysis of the existing conditions and therefore need to be considered in the assessment of future cumulative effects.

Table 4.6-24 Maximum Potential Sulfur Dioxide, Nitrogen Oxide, and Particulate Emissions from the Proposed Projects in the Six-County Project Area in Comparison to Emission Reductions

Project	City/County in Minnesota	SO_2 (tpy)	NO_x (tpy)	PM_{10} [14] (tpy)	BACT / MACT[15]
Increases					
Excelsior Energy, Mesaba Energy Project[1]	Taconite or Hoyt Lakes, St. Louis County and Itasca County	1,390	2,872	503	Yes
Laurentian, Wood Fired Energy Project[2]	Hibbing and Virginia, St. Louis County	50	302	40	Yes
Mesabi Nugget DRI Plant[3]	Hoyt Lakes, St. Louis County	417	953	514	Yes
Mesabi Nugget Phase II[4]	Hoyt Lakes, St. Louis County	7	282	955	Yes
Minnesota Steel Industries[5]	Nashwauk, Itasca County	421	1,505	1,354	Yes
Northshore Mining Company, Furnace 5 Reactivation[6]	Silver Bay, Lake County	56	200	149	Yes
PolyMet Mining, NorthMet Project[7]	Hoyt Lakes, St. Louis County	30	159	1,175	
SAPPI Cloquet[11]	Cloquet, Carlton County	26	7	-5	
UPM/Blandin Paper Mill Expansion, Project Thunderhawk[8]	Grand Rapids, Itasca County	213	169	-7	Yes
U. S. Steel Keetac, Expansion[9]	Keewatin, Itasca County and St. Louis County	124	39	956	
Total Increases		2,734	6,489	5,634	
Reductions					
Ainsworth Engineered - Cook OSB([16]	Cook, St. Louis County	-19	-203	-53	
Ainsworth Engineered - Grand Rapids[17]	Grand Rapids, Itasca County	-2	-92	-50	
Minnesota Power Taconite Harbor Energy Center Unit 2, Emission Control Modifications for SO_2, NO_x and mercury	Schroeder, Cook	-877	-1,158		
Minnesota Power Laskin Energy Center Unit 2, NO_x Reductions[10]	Hoyt Lakes, St. Louis		-1381		
Minnesota Power Boswell Energy Center Unit 3[10]	Cohasset, Itasca	-11,659	-9,683		
U. S. Steel Minntac BACT Reductions[12]	Mtn. Iron, St. Louis		-1,240		
United Taconite Green Production Project[13]	Forbes, St. Louis	-912 to 39	-2,642 to 39	-58	
Total Reductions		-13,469 to -12,518	-16,399 to -13,718	-161	
Net Reductions/Increase		**-10,735 to -9,784**	**-9,910 to -7,229**	**5,473**	

Prepared November and December 2008:

(1) Emission estimates (Phase I and Phase II) based on emissions used in the air quality analysis in the draft EIS, website: http://www.netl.doe.gov/technologies/coalpower/cctc/EIS/mesaba_pdf/Mesaba_DEIS_Appx_B.pdf, accessed on November 29, 2008

(2) Potential to emit from Technical Support Documents for Virginia Public Utilities (MPCA permit #13700028-005) and Hibbing Public Utilities (MPCA permit #13700027-003)

(3) Mesabi Nugget's Proposed Direct Reduced Iron (DRI) Facility: No crushing/grinding at the site; receive concentrate from offsite. Technical Support Document for MPCA permit 13700318-001
(4) Preliminary emission estimates Barr Engineering
(5) Potential to emit from Technical Support Document for Minnesota Steel (MPCA permit #06100067-002)
(6) Northshore Mining's Furnace 5 Project: reactivating 2 crushing lines, 9 concentrating lines, one pellet furnace (Furnace 5); new sources emissions only (MPCA permit #07500003-003)
(7) PolyMet Mining's Proposed Facility: crushing/grinding of ore, reagent and materials handling, flotation, hydrometallurgical processing. Emission estimates from Barr Engineering reports dated November 2008 (RS57A, Draft 03; RS57B, Draft 03; RS57C; RS57D; RS57E) submitted to MnDNR
(8) Net Emission Increase from Blandin Project Thunderhawk MPCA permit #06100001-009
(9) U. S. Steel Keewatin, Keetac mine expansion and restart of taconite processing line
(10) Emission estimates provided by the MPCA from the "Northeast Minnesota Plan Emission Tracking Spreadsheet"
(11) Preliminary net emission change estimates from draft EAW dated 7/1/2008. Plant expansion, new paper machine, new boiler
(12) Emissions reduction estimates are the permit limits minus the 2006 actuals
(13) United Taconite Green Production Project – Improvements to concentrator and pellet plant, fuel changes, installation of pollution control equipment. Emission estimates are preliminary and reflect the range of reductions that could occur depending on the final fuel mix chosen. If SO2 is 39, NOx will likely be close to -2642. If NOx is 39, SO2 will likely be close to -912
(14) PM_{10} emission estimates include point and fugitive emissions for all sources at a facility
(15) MACT = Maximum Achievable Control Technology; BACT = Best Available Control Technology
(16) Facility shutdown Emission reduction estimate based on average emissions for last 5 years of operation from MPCA emission inventory database. Note: the facility has a valid air permit that could potentially be transferred to a new owner.
(17) Facility shutdown Emission reduction estimate based on average emissions for last 5 years of operation from MPCA emission inventory database. Note: the facility has a valid air permit that could potentially be transferred to a new owner.

Emissions of both NO_x and SO_2 have been reduced in northeast Minnesota by reductions from power generation facilities. However, both power generation facilities and the mining facilities contribute to visibility impairment in the area. As discussed in the *Background on Regional Haze* section above, the MPCA currently has a Regional Haze SIP goal to reduce combined NO_x and SO_2 emissions from northeast Minnesota from 2002 levels by 30% by 2018. Current MPCA estimates indicate that emission reductions at power generation facilities and additional reasonably foreseeable projects in northeast Minnesota are not enough to meet the current Regional Haze SIP goal. Therefore, additional mitigation or reductions may be necessary. The MPCA can use its regulatory tools to require further reductions at sources in Northeastern Minnesota or other places within the state if it becomes necessary.

Even though there is a net increase in PM_{10} for all the proposed projects combined, direct PM_{10} emissions are not considered to be a concern for visibility impairment in the BWCAW or Voyageurs National Park as described in Minnesota's Regional Haze SIP (USFS 2008, *Technical Comments on Minnesota Regional haze State Implementation Plan*).

Summary of Visibility Cumulative Effects Analysis

The following items outline the results and environmental consequences of the 2009 Visibility Class I Study:

1. **Class I Area Visibility Gradually Improving or Showing No Trend.** Between 1992 and 2006, visibility in the BWCAW on the 20% worst days showed a downward trend in haze index (i.e., an improvement in visibility), based on a rolling five-year average. The trend since 2000 is also of interest because this reflects the timeframe of the regional haze requirements. This trend was assessed based on data in the revised 2009 Draft Regional Haze SIP. The annual 20% best and 20% worst haze index values for the BWCAW

shows a downward trend from 2002 to 2007. The five year averages from 2003 to 2007 are also lower than the baseline averages from 2000 to 2004. The National Park Service has concluded that through 2005, there was not a trend either improving or declining for Voyageurs National Park. Based on data in the revised SIP, there is no clear trend for Voyageurs National Park. Although visibility on the 20% worst days is improved from 2002 to 2007 for the 20% best and 20% worst days, the 2003-2007 average for the 20% worst days is higher than the baseline average (indicating greater visibility impairment) while the average for the 20% best days shows improvement.

2. **Sulfate and Nitrate Particles Are Largest Contributor to Visibility Impairment**. Ammonium sulfate, ammonium nitrate and organic carbon matter particulates are the largest contributors to visibility impairment in both Class I areas. The ammonium sulfate and nitrate are due to emissions of SO_2 and NO_x, respectively. Each of these components can be naturally occurring or the result of human activity.

3. **Overall Emissions Decreases in Pollutants that are Precursors to Sulfate and Nitrate Particulates.** When the emissions from the proposed projects in northeast Minnesota are viewed together with the concurrent emission reduction projects of SO_2 and NO_x from power generation facilities in northeast Minnesota, there is a net decrease in emissions of both pollutants in the six-county area of northeast Minnesota. As noted in the *Environmental Consequences* section above, current MPCA estimates indicate that emission reductions at power generation facilities and additional "reasonably foreseeable" projects in northeast Minnesota are not enough to meet the current Regional Haze SIP goal. Therefore, additional mitigation or reductions may be necessary to reach the 2018 goal.

4. **15% of 2018 Visibility Impairment Projected to be Due to Northeast Minnesota Emissions.** Predictive modeling done in support of the Minnesota Regional Haze SIP shows that Minnesota sources are expected to contribute approximately 30% of the visibility impairment at Minnesota's Class I areas and approximately 14% of the visibility impairment at Isle Royale (MPCA 2008, *Minnesota Draft Haze SIP – FLM Review Copy*). Of the visibility impairment in the Minnesota Class I Areas, Northeast Minnesota sources contribute about half of the total from Minnesota sources or 15% overall. The remainder is likely due to sources in other states and Canada. Emissions from Minnesota are the single largest contributor to regional haze at its own Class I areas.

5. **Net Effect from Proposed Projects.** The net effect from the proposed projects, the voluntary reductions of power generation facilities and the foreseeable regulatory actions shown in Table 4.6-24 will likely reduce emissions of SO_2, and NO_x in Minnesota. However as addressed above, the MPCA has developed Regional Haze SIP goals to reduce combined NO_x and SO_2 from 2002 levels. The reduction is 20% by 2012 and 30% by 2018. Based on current projections including the Proposed Project, the reductions addressed in this section are not projected to be enough to meet the 2018 goal. The reductions will be enough to meet the 2012 goal.

In the event that additional emission reduction measures are required by the MPCA to meet Regional Haze SIP goals, emissions from the Project may be included for reduction consideration through the MPCA's Regional Haze Rule 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. Whereas amphibole minerals have been found in the Duluth Complex, the Duluth Complex does not contact the Biwabik Iron Formation at the NorthMet deposit.

Regulation of amphibole mineral fibers in Minnesota is based on the landmark 1974 Reserve Mining court case [*United States. v. Reserve Mining Company*, 380 F. Supp. 11, 17 (D. Minn. 1974)]. Northshore Mining's Silver Bay processing plant was formerly operated by Reserve Mining Company. In the 1974 ruling, which addressed 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 based on the science available at the time, evidence existed regarding the potential for exposure to amphibole mineral fibers to cause cancer and other health effects. This led to the construction of a tailings basin in 1980. As discussed below, the Court's definition of amphibole mineral fibers incorporates asbestos[12] and non-asbestos amphibole fibers. The Court found, based on the science available at that time, that since it can be difficult to tell the difference between asbestos and non-asbestos amphibole fibers under the microscope, release of fibers from the facility should be minimized to reduce the potential for health effects. Scientific work, including whether there exists the potential for 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)[13] 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

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[12] 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.

[13] A micrometer (µm) is one millionth (10^{-6}) of a meter.

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; and
- 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 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); and
- 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.[14] Amphiboles also break (or cleave) into smaller fragments when finely ground. Long, thin cleavage fragments[15] 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, according to USGS (2001), "…unless a fiber bundle has splaying ends, it is impossible to determine if a single long, thin particle grew that way (as asbestos) or is a cleavage fragment" (USGS 2001). 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 (ERM 2009) 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

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[14] According to USGS (2001), 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.

[15] According to USGS (2001), 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.

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 Gylseth et al. (1981) 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 considers the role of amphibole fibers in the induction of asbestos-related health effects to be uncertain at this time and they assume that amphibole fibers have the potential for an as yet undetermined toxicity and potency relative to amphibole asbestos. 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

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.

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).[16] 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) provided results for amphibole and serpentine minerals representative of the MEQB (1979) 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) 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. The results of the July/August 2005 flotation pilot testing are summarized below:

16 References to MEQB (1979), SGS (2004), and Stevenson (1978) are as cited by Barr (2007d).

- 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; and
- 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 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 2009) 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 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, 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 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. 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}.

In a September 2007 Supplemental Fibers Data Report (Barr 2007b), PolyMet incorporated project changes made in a July 2007 Supplemental Detailed Project Description (DPD) (PolyMet 2007) 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 (RS58A Draft-02). 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.

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 $PM_{2.5}$ size range a $PM_{2.5}$ 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 $PM_{2.5}$ 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 $PM_{2.5}$ 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 ($PM_{2.5}$). 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.

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 would 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 would 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; and
- The potential for the release of amphibole mineral particles to the air at the Mine Site is low because the ore would not be crushed at the Mine Site and the unpaved road surfaces would 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 $PM_{2.5}$ 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 operational and air pollution equipment controls agreed to by PolyMet represents the highest feasible level of fine particulate matter emissions control. This level of particle control, coupled with the 5 miles to the closest residential community, Hoyt Lakes, further reduces the potential for exposure to airborne amphibole mineral fibers.

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 baseline sample period will continue for a minimum 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 4.6.3.1, 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 4.6.3.1 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 placement of additional large boulders as the rock buttress is vertically extended. 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 would 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 2 miles 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.

Review of aerial photography and public records indicate that there are few noise sensitive areas or receptors such as residences, campgrounds, and national wilderness areas within the Project vicinity. The closest noise-sensitive receptor from the Mine Site is the city of Babbitt located approximately 6 miles to the north (survey data identified a Boy Scout camp located 5 miles away from the Mine Site, but 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 approximately 9 miles from the Mine Site). Other noise-sensitive receptors in the general area of the Mine Site include Skibo (a small residential area), approximately 8 miles to the south-southwest; and the city of

Hoyt Lakes, approximately 9 miles to the southwest.[1] 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.

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 5 miles south, and the Boy Scout camp, which is only used occasionally, located approximately 5 miles south-southwest. Figure 4.7-1 shows the location of all 8 receptors relative to the Mine and Plant Sites. The 8 locations were chosen because they represented the closest noise sensitive receptors and/ or dwellings to the proposed NorthMet Project as indicated in Figure 4.7-1.

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.

Position statements submitted by the tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] It is the position of the tribal cooperating agencies that noise contour maps should be developed for inclusion in this DEIS. 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.

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 2 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.[2]

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 1 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

Position statements submitted by the tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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 harvests on national forest lands.

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. These noise standards would apply to the Project throughout its mine operational years (Year 1 to 20) when elevated sound level activities from mining and crushing operations 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).

Blasting is an activity associated with mining that could result to air overpressure and ground vibrations. 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 6 cycles per second to 200 cycles per second; and
- The maximum peak particle velocity from blasting shall not exceed 1 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 1 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 8 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 farther 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 (Siegel and Ericson 1986). 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, waste rock stockpiles, or berms.

Modeled sound levels from the 16 haul trucks heard at the 5 NSAs nearest 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.

Table 4.7-4 Predicted Nighttime Noise Levels for the Project[1]

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 ($10^{(\text{Ambient Noise}/10)} + 10^{(\text{Project Noise}/10)}$).

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 8 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 (<l train per hour) are expected to deliver ore to the Plant Site, this frequency of traffic is less than that previously experienced on the rail line.

As mentioned in Section 4.7.2, the other potential source of noise emissions is 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 2 or 3 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 6 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.

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. 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 farther 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., 5 miles) away from the city of Hoyt Lakes to the south (NSA #2); and approximately 26,400 feet (i.e., 5 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 miles between them, 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 not have a significant effect on the noise environment during mine operations, Closure, and Post Closure.[3]

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 have reduced sound levels. 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. 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

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Position statements submitted by the tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] Tribal cooperating agencies disagree with this conclusion. This document does not present enough information to make this claim.

(i.e., receivers located upwind would experience a lesser noise impact since noise propagates farther 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 Railroad, it is expected that the HDD equipment would be located no closer than approximately 6,300 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 Railroad 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 Railroad 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 Railroad

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**

Notes:
Distance from the HDD activity to the closest NSAs (City of Hoyt Lakes and the Boys Scout Camp) is approximately 1.2 miles (6,300 feet).
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 21,100 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**

Notes:
Distance from the HDD activity to the closest NSAs (City of Hoyt Lakes and the Boys Scout Camp) is approximately 4 miles (21,100 feet).
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 increase 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 Railroad and Second Creek during pipeline installation is expected to generate noise increases relative to background levels (particularly the HDD crossing at the CN Railroad); 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 elevated sound level activities 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 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 the blast hole density along with detonation delays to keep blasting vibrations below the MnDNR prescribed limits;
- Air overpressure levels should be managed through a reduction of delay weights, appropriate stemming depth, use of shock tubes, and depth of burden (distance of blast from free bench face);
- Blasting should be avoided during unfavorable atmospheric conditions, such as low level inversions or winds toward nearby buildings; and
- Blasting should be scheduled at the same time every day to minimize startle effect.

4.7.4 Cumulative Effects

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 2 miles north of the Mine Site. Because these other noise sources are at least 2 miles or more away 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 2 to 3 miles to the southeast and County Highway 21 located more than 5 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 noise effects of reasonably foreseeable projects (i.e., future developments) within a 10 mile radius of the Project area were also considered over the 20 years of Project mining[4]. Such reasonable foreseeable projects considered include the Mesaba Energy Project, and the Mesabi Nugget Phase II Project. The cumulative noise effects of the Mesaba Energy and Mesabi Nugget Phase II projects (when in operation in ~2012 or 2013) on NSAs is expected to be insignificant since both projects would be located more than 2 miles away from the Plant and Mine Sites and sound levels generally diminishes significantly with distance. Based on the information above, noise levels at residences and other sensitive receptors close to some of these future developments (when in operation) may increase; however, these cumulative increases or impacts are not expected to be significant since the noise levels heard by the receiver would reduce as the distance from the source increases.

Even if it is conservatively assumed 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 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, no cumulative impact issues associated with noise were identified.[5]

Position statements submitted by the tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[4] 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.

[5] 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

Regulatory Framework

Cultural resources is a very general term that includes a wide range of phenomena; including sites with the observable evidence of human activities, sites of religious or cultural significance to Indian Tribes that may have no observable evidence, historic structures and buildings, properties associated with the cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the community's cultural identity, as well as natural resources inexorably linked to cultural beliefs and practices. Cultural Resources Management within Federal and State agencies seeks to identify and consider all of these types of cultural resources with the goal of balancing the need for development with protection.

For Federal agencies the key component of Cultural Resources Management is section 106 of the National Historic Preservation Act (NHPA), of 1966, as amended (16 USC 470). That section reads as follows:

> "The head of any Federal agency having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking in any State and the head of any Federal department or independent agency having authority to license any undertaking shall, prior to the approval of the expenditure of any Federal funds on the undertaking or prior to the issuance of any license, as the case may be, take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. The head of any such Federal agency shall afford the Advisory Council on Historic Preservation established under Title II of this Act a reasonable opportunity to comment with regard to such undertaking". (16 USC 470f)

The Advisory Council on Historic Preservation (Council) promulgated 36 CFR part 800, a regulation that implements section 106 by providing procedures regarding a Federal agency's historic preservation responsibilities and the Council's commenting responsibilities. The procedures outlined in this regulation are commonly referred to as the section 106 process. Central to the section 106 process is the term "historic property". 36 CFR part 800 defines a historic property as follows:

> . . . 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 CFR 800.16 (l)(1)).

For a cultural resource to be included in, or considered eligible for inclusion in the National Register of Historic Places (NRHP) it must be a tangible property such as a district, site, building, structure, or object, that is greater than 50 years old, retains its historic integrity, and meets one or more of the NRHP Criteria for Evaluation. The NRHP Criteria for Evaluation 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 (36 CFR 60.4).

If a cultural resource meets the requirements of the NRHP the USACE, as a Federal agency, must consider the effect of the undertaking, i.e. the Project, on that historic property and provide the Council an opportunity to comment. However, the Council does not typically become involved in the review of individual section 106 cases. The criteria for Council involvement are found in Appendix A to 36 CFR part 800.

In lieu of Council involvement, 36 CFR 800.3(c) directs the Federal agency to identify and consult with the appropriate State Historic Preservation Office (SHPO) or Tribal Historic Preservation Office (THPO) if the undertaking will occur on, or affect, historic properties on tribal lands. Section 101(b)(3) of the NHPA provides for the establishment of SHPOs to provide guidance and assistance to Federal agencies. Section 101(d)(2) of the NHPA allows the assumption of SHPO responsibilities on tribal lands by Federally recognized Indian Tribes. For an undertaking that will occur on, or affect, historic properties on tribal lands where the tribe has not assumed the SHPO responsibilities, the Federal Agency is directed to consult with the Indian Tribe in addition to and on the same basis as the SHPO (36 CFR 800.3(d).

Once the agency has identified the appropriate SHPO, THPO, or Tribal representative as the case may be, 36 CFR 800.3(f)(2) requires the Federal agency to identify Indian Tribes that may attach religious and cultural significance to historic properties in the area of potential effects (APE) and invite them to be consulting parties. The Council’s regulation defines the APE as:

> ….the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist …. (36 CFR 800.16(d).

For the purpose of the discussion in this chapter, direct effects physically alter the historic property in some way and indirect effects are further removed in time or space and diminish some aspect of the historic property, but do not physically alter it. Because the impacts of the proposed project, such as water or air quality, have been the subject of ongoing analysis, the APE for the Project was not determined until August 11, 2009. The USACE has not yet formally coordinated the APE determination in writing.

Only after the APE is defined can a comprehensive identification of historic properties take place. Therefore, the identification of historic properties is ongoing.

The USACE is consulting with three Federally recognized Indian Tribes that have expressed and interest in consultation; the Bois Forte Band of Lake Superior Chippewa, the Fond du Lac Band of Lake Superior Chippewa, and the Grand Portage Band of Lake Superior Chippewa (Ojibwa Bands). It now appears that the Project may have the potential to affect historic properties on Fond du Lac tribal lands. The project may affect historic properties of religious and cultural significance to the Ojibwa Bands on and off reservation, or tribal lands. It is important to note that under section 101(d)(6)(A) of the NHPA and 36 CFR 800.2(c)(2)(ii)(D), the determination of a historic property's religious and cultural significance to Indian tribes is not tied to continual or physical use of the property.

Because of the logistical and cultural complexities involved in identifying historic properties of religious and cultural significance to the Ojibwa Bands, and the problems encountered in defining the APE, a significant amount of consultation and survey work remains to be completed.

In traditional tribal culture and cosmology, natural resources hold great significance. The Ojibwa Bands have emphasized the importance of natural resources to their people, 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 consideration under the NHPA it must qualify as a historic property.

If an historic property is affected, the USACE will follow the provisions of 36 CFR part 800.5 to determine whether the effect is adverse. If an effect is adverse, the USACE will consult to resolve the adverse effect either through avoidance of the effect or mitigation for the effect pursuant to 36 CFR part 800.6. Prior to the issuance of any Department of the Army permit for the project, the adverse effect must either be avoided or the USACE must execute a Memorandum of Agreement among the consulting parties stipulating the appropriate mitigation measures to resolve adverse effect.

Natural resource impacts have the potential to significantly affect 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 natural resource impacts, or impacts to cultural resources that do not qualify for the NRHP, will be addressed in light of Federal tribal trust responsibilities and treaty rights within the 1854 Ceded Territory. This will be discussed later in this Chapter.

4.8.1 Cultural Context

A brief cultural background is presented below to provide context for this evaluation. Additional cultural resource background is needed for both Pre-European Contact and Post-European Contact sections to provide adequate context. The Post-European Contact section will be improved as part of ongoing tribal consultation. This is necessary because of a greater emphasis on environmental impacts, such as impacts to groundwater hydrology or the methylation of mercury in wetlands or lake systems, and their consequential impacts to cultural resources of importance to the Ojibwa Bands. The current version of the Post-European Contact section does not provide sufficient tribal perspective or the relevant expertise for understanding the potential cultural impacts resulting from environmental impacts. This section must also provide a sufficient context for the identification and evaluation of historic properties of religious and cultural significance to those Bands and include tribal oral history and tribal creation stories.

4.8.1.1 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 may be 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 8,000 years before present. 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 inhabitants of Minnesota with resources as far away as the Gulf of Mexico. During the Archaic Period, people in the Great Lakes region began making tools from copper, which occured 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). Other sources indicate that copper tools appear in archaeological contexts during the initial Archaic between 6,000 and 7,000 years ago (Beukens et. al. 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. Later during the Woodland Period, people began using the bow and arrow. Minnesota was probably 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. 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).

4.8.1.2 Post-European Contact

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 Ojibwa Bands due to the opportunity to trade with Europeans (Meyer 1994). The French knew the Ojibwa as Saulteurs and then as Outchibouec (French), later the Americans knew them as the Chippewa. Anishinabe is what they call themselves. The Sioux were the people living in what is now northern Minnesota at the time of French contact. European trade, primarily for furs, created tension among the tribes of the region. As the Ojibwa moved westward, Sioux tribes were pushed southward, and possibly further west (Gibbon 2002).

The Ojibwa people came from the east, migrating westward along the shores of Lake Superior from the St. Lawrence River Valley. Pressures from European trade and from their Iroquois neighbors are often cited as motivation for this move (Risjord 2005), but, this explanation for westward migration is a Euro-American perspective. According to the Ojibwa sacred migration story, in the long ago a prophet at the third of the seven fires beheld a vision from the Creator calling the Anishinabe to move west until they found the place "where food grows on the water". According to the Anishinabe, they migrated through the Great Lakes region, guided by a vision of a *miigis* (cowrie shell) or Sacred Megis (Meyer 1994; Benton-Banai 1979). 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 clans continued to migrate westward to different areas to settle including across the northwestern U.S. border into Canada.

After battles between the Sioux and Ojibwe 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 on a smaller scale (Risjord 2005).

The Ojibwa people seasonally harvested fish and game, including moose, caribou, bear or rabbit, and deer after logging began, along with maple sugar, fruit, berries, roots, and wild rice. 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 lakes and rivers allowed the Ojibwa people to live in four major camps throughout the year, usually right along lakeshores and river banks. Birch bark and cedar wood/bark were employed in home and canoe construction and container manufacture. Sweet grass was also harvested, and often burned for medicinal and spiritual purposes (McClurken et al. 2000). The Ojibwa participating in consultation for the Project state that sage was used and is still used today 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 Ojibwa lifestyles. This is discussed further below.

Beginning in 1837, Ojibwa 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 Ojibwa Bands 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). The Project area is located within the territory ceded under the 1854 Treaty between the Chippewa (Ojibwa) of Lake Superior and the United States.

In 1999, the U.S. Supreme Court held that the usufructuary rights of the Mille Lacs Band and other signatory Bands under the 1837 Treaty had not been extinguished (Minnesota v. Mille Lacs Band of Chippewa Indians, 526 U.S. 172 [1999]). In 2000, the 8th Circuit Court of Appeals acknowledged the continuing rights of the Chippewa (Ojibee) to hunt and fish in the 1854 Ceded Territory, (United States v. Gotchnik, 222 F.3d 506 [8th Cir. 2000]). These legal rulings have confirmed that tribal communities do retain rights to hunt, fish, and gather on lands within ceded territories.

The tribal signatories to the 1854 Treaty of LaPointe (10 Stat. 1109), including the Grand Portage, Bois Forte, and Fond du Lac bands, have usufructuary rights, or the right to hunt, fish, and gather, on 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 Mississippi . . .
>
> 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.

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 Band 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 the USFS indicates it would require PolyMet to acquire the public land if it is to be used for open pit mining purposes, thus converting it to private land. This public land lies within ceded territory boundaries and is subject to 1854 Treaty rights. It is important to note that the signatory Ojibwa Bands may exercise treaty rights on both public and private lands.

4.8.1.3 History of Iron Range

Minnesota became the 32nd state in 1858, which spurred 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 the 1890s (Minnesota Historical Society 2008). Up to that point, only the far eastern portion of the Mesabi Range had been mined for iron, with mostly hand-tools being employed and not on a large commercial scale. (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 consolidating the 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 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 (Lamppa 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) increased demand due to World War II. The Reserve Mining Company was formed in 1942 (Risjord 2005). In 1964, when attention to 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 (Lamppa 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 LTVSMC 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).

4.8.2 Existing Conditions

4.8.2.1 Historic Properties

Background research and field surveys of the Project area have been conducted over a number of years and have focused on archaeological resources and historic structures directly affected by the Project. The potential for indirect effects to historic properties was not given more than cursory consideration because other than mining properties there are no buildings or structures in or near the Project site and the archaeological potential of the area was considered to be low by the agencies. Additionally, because the Project is located in a mining area the potential to affect properties of religious and cultural significance to the Ojibwa Bands was also considered to be low by the agencies. Consequently, it was not anticipated that the Project would significantly affect historic properties.

As a result of consultation with the Ojibwa Bands, it has become apparent that there is a high potential to affect properties of religious and cultural significance to the Bands. Therefore, the APE has now been expanded to include audible and visual effects as well as potential effects from impacts to water and air quality. The potential impacts to water and air quality are the subject of ongoing analysis; however, the Corps believes that it is appropriate to expand the APE to include portions of the Embarrass River, Partridge River, and Dunka River watersheds adjacent to and downstream from the Project as well as the downstream portion of the St. Louis River to Lake Superior. The USACE has not yet formally coordinated this APE determination in writing.

The identification of historic properties is still ongoing, specifically the identification of historic properties of religious and cultural significance to the Ojibwa Bands. In this respect, the Corps has reviewed a plan submitted by the Bois Forte Band for the identification historic properties and has coordinated that plan with Grand Portage and Fond du Lac bands for their approval and use. It is anticipated that implementation of that plan will ensure that these properties are given full consideration during the section 106 process.

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 that included background research and a selective visual reconnaissance. They presented an evaluation of the 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 harboring archaeological resources. The archaeological potential of other portions of the study area is poorly understood, primarily because very little field survey has been conducted in such areas. The 106 Group considered upland areas in the vicinity of the Partridge River and larger wetlands were to have high potential for archaeological resources. The study identified three potential historic properties; the LTVSMC processing facility and associated mining features, the facility railroad spur, and a logging camp, Knot Camp.

Soils Consulting (RS75, Soils Consulting 2006) conducted a Phase I Archaeological Survey by selectively sampling landscape types considered to have the highest potential for pre-contact archaeological sites. This strategy was coordinated 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 material is located are consistent with expectations for Late Paleo-Indian or Archaic archaeological sites. A Phase II evaluation of the archaeological site was conducted in 2008 by Soils Consulting. Based on the results of that survey, the USACE determined that the “NorthMet Site” was not eligible for listing on the NRHP. The SHPO concurred with this finding in 2009.

Soils Consulting located the previously identified Knot Camp and reported that its integrity had been significantly compromised by impacts from recent logging activities. Scattered surface debris consistent with a historic logging camp was noted. However, no structural remains or associated cultural features were identified. Knot Camp does not appear to be eligible for listing on the NRHP and is located out of the area of direct ground disturbance. The SHPO has concurred with this determination.

Soils Consulting also attempted to located two Indian trails that appear on Sheet 17 of the Trygg Maps (1966). Sheet 17 shows the trails to pass through the NorthMet mine pit area. Trygg Maps are a composite of the United States and surveyor’s original plats and field notes from the nineteenth century land office surveys. The field crew was unable to locate either trail.

USACE has coordinated the results of the archaeological surveys with the SHPO (USACE 2007; USACE 2009; SHPO 2007) and based on strategic sampling of the Project area, the SHPO and

USACE concur that no further efforts are required to identify archaeological resources within the APE.

The USACE also coordinated the results of Soils Consulting's investigations with the Ojibwa Bands. A consultation meeting was also held between the Bands, Soils Consulting, and the USACE in July 2008 to resolve concerns with the survey methodology and results. The Ojibwa Bands still have concerns about the archaeological survey coverage and the identification of the Indian trails. The USACE will continue consultation to resolve concerns with survey coverage and further address the trails as properties of cultural significance to the Bands.

Landscape Research LLC (Zellie 2007) evaluated the NRHP eligibility of the LTVSMC facilities. 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 as a whole did not appear to meet the criteria for listing on the NRHP as an historic district. However, the report recommended that the LTVSMC Concentration Plant and Railroad are eligible and the 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 NorthMet Closure Plan calls for building demolition in accordance with Minnesota Rules, part 6132.3200 (RS52, Barr 2007).

In summary, cultural resource studies to date have been of a limited nature and have only involved the identification of archaeological resources and historic structures in the Project area. Consultation with the Ojibwa Bands has largely focused on the concept of natural resources as cultural resources, the logistics of how the identification of historic properties of importance to the Bands could be accomplished, and the appropriate definition of the APE. The identification of historic properties of religious and cultural significance to the Ojibwa Bands has yet to be completed, but a plan to accomplish this work is being implemented.

The studies completed to date in the Project area have identified historic properties as summarized in (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 NRHP eligible
LTVSMC railroad	• Overall, not NRHP eligible • Portion associated with concentration plant is eligible
"NorthMet Site" (archaeological site)	• Not NRHP eligible

4.8.2.2 Natural Resource Use

As briefly discussed at the end of the Regulatory Framework section of this chapter, natural resources hold a great significance in Ojibwa culture and cosmology. 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 Ojibwa natural resource use throughout the region. 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. Several excerpts are included here to demonstrate the potential impact that a large industrial facility may have on the exercise of treaty-reserved rights. The report also contains recommendations that should be considered 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. This excerpt discusses the importance of particular locations in Ojibwa culture.

> 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.

This 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.

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, which do exist in the Project area (see Section 4.3). The use of natural resources within the Project area has not yet been documented and must be considered as part of further consultation.

However, as discussed above, Ojibwa use of the Project is documented on Sheet 17 of the Trygg Maps, which shows the intersection of two Indian trails near the location of an Indian village. Both the intersection of the trails and the village site are in what is now the proposed Project area. The trails represent well established travel corridors, one is labeled Lake Vermillion to Beaver Bay (possibly on Lake Superior). The presence of a village site is a strong indication of the importance of this location.

During the interviews to be conducted for the identification of historic properties of cultural and religious significance to the Ojibwa Bands, information about the Project area as well as the entire APE will be gathered and evaluated. Cultural resources that do not qualify as historic properties, but are important to the Ojibwa Bands will be considered by the USACE under the Federal trust responsibilities and the 1854 Treaty rights.

Additional discussion of natural resources is provided in various resource sections of this DEIS (see Sections 4.1-4.14).

4.8.3 Impact Criteria

Impacts to historic properties, which may include historic structures, archaeological sites, or properties of religious and cultural significance to the Ojibwa Bands, would be considered significant if that impact meets the criteria of adverse effect found in 36 CFR 800.5(a)(1)

The impact criteria recognize the importance of natural resources to Ojibwa culture even when tribal use of a natural resource may not qualify that resource as a historic property. The right to hunt, fish, and gather on lands within the 1854 Treaty Ceded Territory is protected by the 1854 Treaty. Limitation or elimination of access to public lands within the Ceded Territory for these purposes as provided by the 1854 Treaty would be considered an impact to treaty rights. The loss of traditional use areas would be considered a cultural impact, because in Ojibwa culture commonality of place is essential and the replacement of those sites may not adequately replace their cultural value.

It is the position of the tribal cooperating agencies that this is far from sufficient to address impacts to the Ceded Territory. The USACE understands that impacts to Ojibwa culture may occur when there are disruptions of the patterns and interactions, both material and non-material, in relation to the environment. In this case, the Ceded Territory may be considered the environment. The patterns and interactions with this environment have evolved through hundreds of years (i.e. cultural geography). The 1966 Trygg maps, through the numerous Indian trails, village sites, and place names scattered across the region, demonstrate these patterns and interactions. The USACE will continue consultation with the Ojibwa Bands to better understand how the Project will impact Ojibwa cultural patterns and interactions with the environment.

4.8.4 Environmental Consequences

4.8.4.1 Proposed Action

As discussed in the Existing Conditions Section, cultural resource surveys have been limited in scope and focused on archaeological sites and historic buildings or structures. Consequently, the only historic properties known at this time within the APE are the LTVSMC Concentration Plant and the facility railroad spur. Both historic properties would be adversely affected by the proposed modifications for reuse and by the demolition to occur after facility closure.

The identification of historic properties of religious and cultural significance to the Ojibwa is the subject of ongoing consultation between the USACE and the Ojibwa Bands. Ongoing consultation may identify other historic properties within the APE. The potential impacts to any historic properties identified will need to be assessed.

Beyond the potential impacts to historic properties, impacts to the Ojibwa Band's use of some natural resources would occur. Signatory tribes are entitled access to these natural resources to the extent rights are afforded by the 1854 Treaty. In the course of consultation, tribes have expressed concern that impacts to wetlands and other water resources could affect the natural resources available for their use. Although wetlands impacts would be mitigated, most of the proposed compensatory wetlands mitigation would be located outside the Ceded Territory and would not mitigate potential impacts to the cultural relationship to those resources. Project impacts to the cultural geography of the Ojibwa Bands and its relationship to the 1854 Ceded Territory is poorly understood. Natural resource impacts are evaluated in Sections 4.1 through 4.14.

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 substantially diminish, and could preclude, public or Ojibwa Band access to current public lands within the Project Area. Impacts to the hunting, gathering, and fishing rights resulting from land ownership changes may be compensated for, at least in part, by a proposed land exchange in which new land would be acquired for inclusion in the National Forest System in exchange for the land occupied by the Project. Should this occur, access to natural resources on the exchanged land by 1854 Treaty signatory tribes may be available. The extent to which this measure would be effective in offsetting these natural and cultural resource impacts would depend on the location of the exchanged lands and the type and degree of resources that it would contain. PolyMet intends to propose private lands within the 1854 Ceded Territory. The effects of this land exchange would be evaluated in a separate analysis prepared by the USFS within any environmental review process that is required to assess the impacts of the land exchange. The USFS is consulting with the Ojibwa Bands regarding this land exchange issue.

Of particular concern to tribal representatives is the potential impact to wild rice beds. Recent (August and September 2009) field surveys found wild rice at various locations along the Upper and Lower Partridge River, to Embarrass River, and further downstream in the lower St. Louis

River. Fairly dense stands were found in the Lower Partridge River and Cedar Island Lake along the Embarrass River. Environmental consequences of the Project that may impact wild rice are discussed in Section 4.1.

Tribal concerns regarding impacts on and access to plant and animal resources have been identified during tribal consultation.

4.8.4.2 No Action Alternative

The No Action Alternative would require the complete dismantling of the existing LTVSMC processing facilities under the existing mine Closure Plan, while the Proposed Action would retain and temporarily reuse the facility, which is preferable from an historic preservation standpoint. However, demolition of the processing facilities would still occur at Closure under the Proposed Action.

Under the No Action Alternative, the LTVSMC Plant Site would be reclaimed and restored. Public access to the site for natural resource use would require the site be converted from private to public ownership, or permission granted for public access. Access to existing public lands within the Mine Site would continue as it is currently, which would allow access for the traditional use of natural resources by Ojibwe people.

Other than the LTVSMC concentrator building, under the No Action Alternative there would be no direct or indirect effects on historic properties, potential historic properties, or properties of cultural and religious significance to the Ojibwa Bands.

4.8.4.3 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 identified to date 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 the Ojibwa Bands pursuant to the 1854 Treaty, are described in the corresponding natural resource sections of this DEIS.

4.8.4.4 Mitigation Measures

The Project would adversely affect the Concentration Plant and facility railroad spur through construction and operation of the Plant Site. This adverse effect would be mitigated by Historic American Building Survey/Historic American Engineering Record documentation of the LTVSMC Concentration Plant and railroad spur prior to initiation of any modifications that would affect these properties. A Memorandum of Agreement, which is currently in development, will be executed among the USACE, the SHPO, and Polymet, and will detail the specifics of the mitigation.

The Project would also impact the 1854 Treaty signatory tribes through the potential loss of access to lands and natural resources within the Ceded Territory. In addition to loss of access, cultural impacts to the Ojibwa Bands may occur from the diminished quality and quantity of important natural resources. The land exchange under consideration would be based on dollar value, as opposed to equivalent acreage. Signatory tribes could incur a net loss of access to public lands within the Ceded Territory from the Project; however, PolyMet intends to propose private lands within the 1854 Ceded Territory. As part of its NEPA process for the proposed land exchange, the USFS is consulting with the Ojibwa Bands 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 the Ojibwa Bands to identify the extent of the APE due to indirect impacts for the Project is ongoing. Once the APE is identified and an analysis of indirect impacts is completed, further mitigation measures may be identified.

4.8.5 Cumulative Effects

The Final SDD (MnDNR 2005) did not identify any cumulative effects associated with cultural resources. Subsequent analysis in this DEIS concludes that the only known adverse effects resulting from the Project would be the modification and eventual demolition of the LTVSMC Concentration Plant and facility railroad spur, which are eligible for listing on the NRHP. These effects would also occur under the other alternatives, including the No Action Alternative.

Tribal representatives have indicated that the Project would have an effect on its usufructuary treaty rights within the Ceded Territory by removing the Project site from public ownership. The tribes have also raised concerns regarding the location of proposed wetland mitigation being located outside the Ceded Territory. The potential cumulative effects related to these land use-related treaty issues, as distinct from historic properties discussed herein, are addressed in Section 4.14 (Cumulative Effects).

The cumulative impacts of past, present, and future mining projects to Ojibwa culture are unknown, but may be very significant. Recently Tribal representatives have recently suggested that the 1854 Ceded Territory may qualify as a TCP and therefore may meet the criteria for listing in the National Register (Van Norman 2009). The USACE has determined that the Ceded Territory does not meet the criteria for listing in the National Register. This does not diminish the significance of the Project impacts to the cultural geography of the Ceded Territory.

It is the positions of the Ojibwa Bands that this chapter cannot be completed without significant additional consultation with the Tribal cooperating agencies, development of full, Tribal surveys of historic properties of religious and cultural significance to tribes, 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 earlier changes and comments, 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.

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, St. Louis County zoning ordinance including the County Water Plan; St. Louis River Management 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 have been having detailed discussions exploring the feasibility for a land exchange, which would remove the Project from National Forest land; 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 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 vehicles and equipment access. 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 Mine Site and represent a southern access point to the Minnesota state lands 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 the incorporated municipalities. The majority of the Project area is within the incorporated limits of the cities of Babbitt and Hoyt Lakes; however, a small portion of the Tailings Basin is within the unincorporated Waasa Township and therefore subject to jurisdiction under the County plan.

The St. Louis River Management Plan (The Plan) was developed by the St. Louis River Board (The Board) in 1994 with the goal of environmental protection and wise use of the St. Louis River and its adjacent lands from its headwaters to the Fond du Lac Dam. The Plan was subsequently incorporated into the St. Louis County Land Use Plan (Section 21) in 1994. The Board is comprised of county and township representatives from Carlton County, Lake County, St. Louis County, and the Fond du Lac Reservation as these entities exercise land use control and jurisdiction along the St. Louis River. The goals of The Plan are to actively manage development in the St. Louis River watershed and adjacent lands (generally within 0.5 mile of the shoreline) to promote preservation and improvement of water quality, recreational opportunities, ecological health, and archaeological resources. The Mine and Plant Sites lie on tributaries to the Upper St. Louis River.

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. The City of Hoyt Lakes has not developed a comprehensive plan.

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 exploring the feasibility for a land exchange. 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. PolyMet intends to proposed private lands within the 1854 Ceded Territory. A land exchange would resolve the current split estate between federal surface overlying private minerals by consolidating the surface ownership and mineral rights. 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 (USFS 2004a, pages 2-51 - 2-52). The land exchange would convert National Forest 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 National Forest lands in this area for the roads 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 that includes the use of non-native and potentially invasive species (RS52, Barr 2007), 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 (see Section 4.3.3).

The Dunka Road, which 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 the Project would not create any access hardships to State lands (Magnuson 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, *NorthMet Mine and Ore Processing Facilities Environmental Assessment Worksheet (EAW)* - 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.

The St. Louis River Management Plan identifies guidelines for the development of the St. Louis River and its adjacent (within 0.5 mile) lands. While the Project is greater than 0.5 mile from the St. Louis River shoreline, The Plan is part of the St. Louis County Comprehensive Land Use Plan, with which the Project is consistent.

Summary

The USFS and PolyMet are exploring the feasibility of a land exchange, which would convert Project lands that are currently National Forest lands 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 Land Use Plan, the City of Babbitt Comprehensive Plan, and the City of 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 Mine and Plant Sites under the No Action Alternative would be compatible and consistent with existing land management plans, regulations, and practices.[1]

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 are exploring the feasibility of a land exchange. Following successful completion of the land exchange, these alternatives would not be subject to federal land management guidelines. These alternatives would also propose to revegetate with a seed mix that includes non-native and invasive species, which would be inconsistent 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, these alternatives would be consistent with all local land use policies.

4.9.3.4 Potential Mitigation Measures

As described above, 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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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.

stabilize disturbed areas and re-establish soil nutrients. A way 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 in accordance with *Minnesota Rules*, part 6132.2700, subpart 2, item C. 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 Effects

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 complete 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 measure (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 effects during the life of the Project and Post-Closure relative to Compatibility with Plans and Land Use Regulations.[2]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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 socioeconomic 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 Resources (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, SEH and UMD 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, SEH and UMD 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, SEH and UMD 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, SEH and UMD 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, SEH and UMD 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, SEH and UMD 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 (SIC) codes, 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, SEH and UMD 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, 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, SEH and UMD 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, SEH and UMD 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, SEH and UMD 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, SEH and UMD 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; and
- 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 (including 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 Impact Analysis for Planning (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; and
- 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 would 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.[1]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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.

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, 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.[2]

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

2 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.

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 would 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%[3] 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.

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[3] Assumed 10% of workers would commute weekly from larger centers and stay in hotels / motels, rather than seek independent housing

Table 4.10-13 Anticipated Steady State Operation Employment Levels

Area	Total Number
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 per year.

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 6.875% 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 6.875% 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 once 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 (Figure 4.10-2). 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 would be transferred via Lake Superior and through the ports of Duluth and Superior. These goods would 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. 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 directly 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

Most of the Mine Site is located within 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. If the proposed land exchange occurs, this land would be removed from the National Forest and replaced in a location to be determined. 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 fluctuations. 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 are other 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 potentially significant adverse socioeconomic effects from the Project, therefore, no mitigation measures are proposed.

4.10.4 Cumulative Effects

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 NOvA 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 Essar Steel Minnesota DRI/ steel plant	Future	Essar Steel (Minnesota Steel) is developing a $1.6 billion project in Nashwauk, Minnesota that fully integrates mining through steelmaking. This project would 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 Essar Steel Minnesota taconite mine and tailings basin	Future	Essar Steel (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 Essar 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 modeling 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, SEH and UMD 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[4]	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, SEH and UMD 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.

4 The economic impact modeling (IMPLAN) was conducted prior to February 2006. Projects that were proposed and in the public domain at the time of modeling 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[5]	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, SEH and UMD 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

Notes: Expansion Plants (1) represents taconite expansion plants that are constructed the year prior to Year 1 and are first operational during Year 1. Expansion Plants (2) represents taconite expansion plants that are under construction in Year 1 and operational starting in Year 2.

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

[5] The economic impact modeling (IMPLAN) was conducted prior to February 2006. Projects that were proposed and in the public domain at the time of modeling 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 relocate 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.

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 3,000,000 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 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 located immediately north, east, and south of the Mine Site.

The nearest potential visual receptors to the Mine Site are located approximately six miles to the east along Lake County Road 2 within the incorporated limits of the City of Babbitt. Other rural homes are approximately seven miles to the south near the unincorporated village of Skibo. There are no major trails within the Superior National Forest adjacent to the Mine Site that would expose recreational users to the mine. To the immediate west of the Mine Site are

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uninhabited forests, wetlands, and open land. The City of Hoyt Lakes is approximately nine miles to the southwest of the Mine Site.[1]

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 legacy mine pits and waste rock stockpile sites to the south and east, and a railroad to the west. Second Creek and its headwater wetlands 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 cities 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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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 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 precedence, 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.

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"Modification Management Class" for 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 its 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).

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.[2]

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 height 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 used when the stockpiles are active.

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

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

2 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 harvests on national forest lands.

proposed mining facilities would not introduce visual elements to surrounding viewpoints that are in stark contrast to the regional visual character.[3]

The Mine Site would be in operation 24 hours per day; therefore, nighttime safety lighting of the active 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.

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 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/2E to approximately the same elevation as the existing Cell 2W. The hydrometallurgical residue 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; 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 an approved vegetation mix. The long-term visual effects at the Plant Site would be beneficial as the LTVSMC processing plant would be revegetated with appropriate species.

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 Cliffs Erie 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

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] Tribal cooperating agencies disagree with this conclusion. This document does not present enough information to make this claim.

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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 more 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 slightly less intrusive from surrounding viewpoints as the temporary stockpiles would be removed when the East Pit becomes available for storage.

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 a portion of 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

As described above, the Proposed Action would operate 24 hours a day and would contribute to a localized “glow” in the night sky. A recommend mitigation measure is shielding the operation light sources downward to reduce light impacts.

4.11.4 Cumulative Effects

The Project, as proposed, would be visually secluded from the surrounding area by the Giants Range formation and surrounding vegetation such that it would not influence the surrounding landscape. In addition, implementation of the above referenced mitigation measure (i.e.,

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shielded lighting) would minimize impacts to the night sky. Therefore, there would be no long-term impacts during the Project life and Post-Closure relative to Visual Resources and no cumulative effects analysis would be warranted.[4]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

4 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.

4.12 HAZARDOUS MATERIALS

The Project would use or generate as waste the following hazardous materials:

- Fuels, maintenance products, and solvents – diesel fuel, gasoline, oils, greases, anti-freeze, and solvents used for equipment operation and maintenance;
- Plant reagents – sodium hydrosulfide, sodium hydroxide, acids, flocculants and anti-scalants used in processing plant applications;
- Mine Site WWTF chemicals – calcium hydroxide (or hydrated lime), aluminum hydroxide, sodium hydrosulfide, or iron salts used in chemical precipitation processes (RS29T, Barr 2007);
- Blasting agents – ANFO (ammonium nitrate fuel oil mixture), emulsions, emulsion blends (a blend of ANFO and emulsion), blasting caps, initiators and fuses, and other high explosives used in blasting; and
- Other materials – assay chemicals, and other by-products classified as hazardous waste.

Issues relating to the presence of hazardous materials may include the accidental releases of these materials during transportation, storage, handling, and use at the Project and their potential impacts on the environment. For the purpose of this discussion, the term "hazardous *materials*" refers to the above listed products in general and does not indicate a regulatory definition unless otherwise stated. However, the term "hazardous *waste"* does indicate a regulatory definition, and materials in this sub-category are subject to state and federal disposal regulations. The environmental resources that could be potentially affected by these hazardous materials if they are accidentally released include air, water, soil and ecological resources.

There are several federal and state regulations that establish management and reporting requirements for hazardous materials that would be applicable to the Project. The statutes to be followed would include, but not be limited to:

- EPA 40 CFR 112 – Oil Pollution Prevention;
- EPA Section 112 of the Clean Air Act – Hazardous Air Pollutants;
- DOT 49 CFR Subchapter A – Hazardous Material and Oil Transportation;
- Mine Safety and Health Act (MSHA) Rule 30 CFR Part 47/ Occupational Safety and Health Administration (OSHA) Rule 29 CFR 1910.1200 (HazCom rules);
- *Minnesota Statutes*, section 115.061 – Minnesota State Guidelines for responding to Spills and Releases;
- *Minnesota Statutes*, chapter 7151 - Aboveground Storage of Liquid Materials;
- *Minnesota Statutes*, chapter 7045 - Hazardous Waste; and
- *Minnesota Statutes*, chapter 7035 - Solid Waste.

4.12.1 Existing Conditions

There are approximately 62 Areas of Concern (AOCs) from the former LTVSMC mining operations. These are discussed in Section 4.1. There is no known existing contamination by hazardous materials at the Mine Site.

4.12.2 Impact Criteria

Several criteria define the impacts from the accidental spill, release, or discharge of contaminants or hazardous material on the environment. The basic principle of these criteria is the protection of people and the environment. Based on this principle, the Project would have a significant environmental impact if the following were to occur:

- A spill, release, or discharge of any hazardous or other material during transportation which, if not recovered in a timely manner, may cause pollution of waters of the state or cause other harm to the environment or to the public;
- A spill, release, or discharge of a hazardous or other material during handling or use which may cause pollution of waters of the state or cause other harm to the environment or to the public;
- Hazardous emissions or handling of hazardous or acutely hazardous materials that has the potential to cause harm to the public or the environment; and
- A spill, release, or discharge from storage facilities on the site exceeding the volumes of the primary and secondary containment structures and which could not be recovered in a timely manner and thus pollutes waters of the state or causes other harm to the environment or to the public.

4.12.3 Environmental Consequences

4.12.3.1 Proposed Action

Operation of the Project would involve the transportation, storage, handling, use, and disposal of process consumables and wastes, some of which are hazardous materials. A list of materials and their classifications that would be used during Project construction, operations, and Closure are provided in Table 4.12-1. The estimated delivery frequency, volumes, and estimated annual use of these materials are also listed in Table 4.12-1.

Table 4.12-1 Materials used during Construction, Operation, and Closure of the Project

Material	Classifications & Precautions	Environmental Concern	Storage Capacity	Deliveries		Annual Use
				Means	Proposed Action Monthly Delivery	Proposed Action
ANFO *(Mixture of ammonium nitrate, and fuel oil)*	Explosive 1.1D or 1.5D: Irritant to skin and eyes. May cause nausea if ingested and irritation to nose and throat if ingested	Harmful to aquatic life at low concentrations.	None - No Onsite management	Vendor/Truck	Approximately 56 Trucks	TBD
Booster (Solid – Cord Sensitive)	Explosive 1.1D Eye irritant. Skin irritant. Inhalation of dust may cause irritation, sneezing or coughing	May cause elevated nitrate levels in water and could impact aquatic animals.	None – No Onsite Management	Vendor/Truck	TBD	TBD
Emulsion	Explosive 1.5D Eye irritant. May be harmful if ingested. Inhalation may cause dizziness, nausea or intestinal upset.	May cause elevated nitrate levels in water and could impact aquatic animals.	None – No Onsite Management	Vendor/Truck	TBD	TBD
Diesel Fuel	Flammable: Continued exposure to vapors can irritate eyes and lungs. Potentially fatal if ingested.	Any spill or release may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals	<u>Mine:</u> 3 - 12,000 gal or 2 - 20,000 gal <u>Locomotives:</u> 15,000 gal <u>Plant:</u> 12,000 gal	Tanker Truck	74 loads (Truck)	<u>Mine:</u> 5,910,000 gal/yr <u>Plant:</u> Uncertain, but relatively minor <u>Locomotives:</u> 473,040 gal/yr
Grease	Mild skin irritant, ingestion may cause discomfort	Any spill or release may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals	Existing Bulk Tanks at Area 1 and Area 2 Shops	Bulk Tank	Less than 1 truck per month	<u>Mine:</u> unknown <u>Plant:</u> Uncertain, but relatively minor <u>Locomotives:</u> 16 lb/yr – each locomotive
Lubricating Oil	Minimal health hazards	Any spill or release may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals	<u>Mine:</u> 2,000 gal <u>Plant:</u> 2 – 7,000 gal 2 – 12,000 gal 1 – 12,338 gal	Tanker Truck	2 loads per month	<u>Mine:</u> 47,000 gal/yr <u>Plant:</u> Uncertain, but relatively minor <u>Locomotives:</u> 200 gal/yr – each locomotive

Material	Classifications & Precautions	Environmental Concern	Storage Capacity	Deliveries: Means	Deliveries: Proposed Action Monthly Delivery	Annual Use: Proposed Action
Transmission Oil	Minimal health hazards	Any spill or release may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals	Mine: 1,500 gal	Tanker Truck	Less than 2 loads per month	Mine: 33,000 gal/yr
Hydraulic Oil	Minimal health hazards	Any spill or release may cause absorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals. Bio-accumulation is unlikely due to the very low water solubility, Bio-availability to aquatic organisms is minimal.	Mine: 2,000 gal Plant: 2 – 2,500 gal	Tanker Truck	Less 1 load per month	Mine: 13,000 gal/yr Plant: Uncertain, but relatively minor
Coolant *(Ethylene Glycol Mix)*	Harmful or fatal if swallowed; eye, skin, and respiratory irritant	Practically non-toxic to aquatic organisms on an acute basis.	Mine: 600 gal Plant: 6,000 gal	Drums and Tanker Truck	1 delivery per month	Mine: 12,000 gal/yr Plant: Uncertain, but relatively minor
Gasoline *(Light Vehicles)*	Harmful or fatal if swallowed; eye, skin, and respiratory irritant	Any spill or release may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals	Plant: 2 - 6,000 gal	Tanker Truck	2 deliveries per month	Plant: 500 gal/day or 178,000 gal per year
Degreaser	Skin and eye irritant, potential inhalation hazard	Any spill or release may cause harm to aquatic plants and fish. Should not be released undiluted into the environment.	Plant: 1 - 400 gal 1 – 2,500 gal	Drums and Tanker Truck	As needed to keep full- less than 1 delivery per month	Uncertain, likely less than 15,000 gal
Used Oils	Minimal health hazards	Any spill or release may cause a visible sheen or deposit of a sludge or emulsion to surface waters creating a hazard for plants and animals	55 gal drums or storage tank	Tanker Truck	Removed from site as needed typically by vendor with bulk truck; Approximately twice per month	Mine: 47,000 gal/yr Plant: Uncertain, but relatively minor Locomotives: 200 gal/yr – each locomotive
Caustic *(NaOH)*	Skin and eye irritant, corrosive	No known environmental effects.	1,100 gallon storage tank	Tanker Truck	1 load/mo	66 t/year

				Deliveries		Annual Use
					Proposed Action	
Material	**Classifications & Precautions**	**Environmental Concern**	**Storage Capacity**	**Means**	**Monthly Delivery**	**Proposed Action**
Cobalt Sulfate	Health Rating Moderate (2) Skin and respiratory irritant	Toxic to fish if released into waters.	1,200 lbs	Truck Deliveries of 67 lb bags	17-18 bags by common carrier	35 t/year
Flocculent *(MagnaFloc 10)*	Inhalation Irritant	No known environmental effects.	1,875 lb bulk bags	Truck	1 truck every 2 months	16.5 t/year
Flocculent *(MagnaFloc 342)*	Low overall toxicity	Toxic to some species of fish if released into waters.	1,875 lb bulk bags of powder	Freight	Less than one truck per month	26 t/year
Flocculent (MagnaFloc 351)	Low overall toxicity	No known environmental effects.	1,875 lb bulk bags of powder	Freight	Less than one truck per month	180 t/year
Sulfuric Acid	Skin and eye irritant, corrosive	Toxic to some species of fish if released into waters.	78,700 gallon storage tank with secondary containment	Bulk Rail Car	3 tank cars/mo	2,998 t/year
Hydrochloric Acid	Skin and eye irritant, corrosive	When released into the soil, this material is not expected to bio-degrade and may leach into groundwater.	59,500 gallon storage tank with secondary containment	Bulk Rail Car	6 tank cars/mo	6,173 t/year
SX Extractant	DOT Combustible material or (mild) corrosive	When released, this material may cause contamination of soil, surface water, or groundwater.	265 gallon tanks	Freight	1 delivery/mo	24 t/year
SX Diluent	Flammable Liquid, Harmful or fatal if swallowed; eye, skin, and respiratory irritant	When released, this material may cause contamination of soil, surface water, or groundwater.	7,400 gallon storage tank	Freight	1 delivery every 2 mo	130 t/year
Liquid Sulfur Dioxide	Extremely corrosive to exposed tissues, DOT Poison Gas, Corrosive	Toxic to some plants and animals if released into waters.	30,000 gallon pressurized storage tank with secondary containment	Bulk Rail Car	3 tank cars/mo	2,866 t/year
Sodium Hydrosulfide	Extremely corrosive to exposed tissues. Contact with acid releases toxic gas. DOT Corrosive	Toxic to aquatic organisms if released into waters.	52,600 gallon storage tank	Tanker Truck	2 tankers/month	847 t/year
Potassium Amyl Xanthate (PAX)	DOT Spontaneously Combustible. Mild irritant. Heating and moisture produces HS2, a toxic gas.	Toxic to animals in large quantities. Contact with water liberates extremely flammable gases, which can cause rapid burning and release of toxins into the air.	Approximate 30,000 gallon Storage Tank	750 Kg Bulk Bags, 25 bags per truck load	Approximately 5 trucks per month	1,075 Short Ton

Material	Classifications & Precautions	Environmental Concern	Storage Capacity	Deliveries		Annual Use
					Proposed Action	
				Means	Monthly Delivery	Proposed Action
Methyl Iso Butyl Carbinol	Flammable Liquid	This material is readily bio-degradable and practically not bio-accumulable and is slightly adsorptive in soils and sediments. Practically non-toxic to aquatic animals if released into waters.	Approximate 10,000 gallon Tank	Tanker Truck	Approximately 6 trucks per month	1,124 Short Ton
Guar Gum (Galactosol)	Harmful if swallowed	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.	70 lb. bags in powder form	Freight	1 delivery/month	9 t/year
Limestone	Harmful if swallowed; eye, skin, and respiratory irritant	Airborne particulates may cause some harm to environment dependent on concentrations	Bulk - stockpiled Onsite	Bulk Rail Car	2 100-car trains per week from April to October	250,000 t/year
Lime	Eye and skin irritant	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.	Bulk - Lime Silo	Freight	150 loads/mo	58,100 t/year
Magnesium Hydroxide	Harmful if swallowed; eye, skin, and respiratory irritant	Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.	Storage Tank	Bulk Rail Car	11 tank cars/mo	17,500 t/year
Grinding Metals (metal alloy grinding rods and balls)	Harmful if swallowed; eye and respiratory irritant, if fine particles	Airborne particulates may cause some harm to environment dependent on concentrations	None required	Bulk Rail Car	13 rail cars/mo	15,600 t/year
Flotation Activators (copper sulfate)	Harmful if swallowed; eye and respiratory irritant	Toxic to fish and plants if released into waters.	9,200 gallon Activator Storage Tank	Reuse from Oxidation Autoclave	Not Applicable	650 t/year

Transportation

All hazardous materials would be transported to the site by commercial carriers in accordance with state and federal hazardous materials shipping requirements. Carriers would be licensed and inspected as required by the Minnesota Department of Transportation. Tanker trucks would be inspected and have a Certificate of Compliance issued by the Minnesota Motor Vehicle Division. These permits, licenses, and certificates are the responsibility of the carrier. Federal regulations (49 CFR) require that all shipments of hazardous materials be properly identified and placarded. Shipping documents must be accessible and include Material Safety Data Sheets (MSDS) that contain information describing the hazardous material, immediate health hazards, fire and explosion risks, immediate precautions, fire-fighting information, procedures for handling leaks or spills, first aid measures, and emergency response telephone numbers.

It should be noted that hazardous wastes would also need to be transported from the Plant and Mine Sites for proper disposal. Transportation of these waste streams would have to adhere to all applicable state and federal regulations including requirements for Hazardous Waste Manifests with shipments, labeling and/or using placards, and emergency information requirements. PolyMet proposes to handle these tasks through either trained employees or a hired contractor; however, a final determination has not been made.

As identified in Table 4.12-1, trucks would be used to transport a variety of hazardous materials to the Plant and Mine Sties. Shipments of hazardous materials would originate from various cities. The risk of accidental truck spills was evaluated using two representative hazardous materials, diesel fuel and PAX Flotation Collector (PAX FC), based on the relatively large quantity of deliveries and health risk characteristics of these materials. Approximately 74 tanker truck loads of diesel fuel and 2 truck loads of PAX FC would be delivered monthly. These quantities amount to approximately 17,800 and 480 shipments of diesel fuel and PAX FC, respectively, based on an estimated 20 years of mine life.

For this evaluation, both materials were assumed to be shipped from Duluth. These materials would be transported approximately 60 miles along State Highway 53 (divided highway) from Duluth to Eveleth and then approximately 20 miles along State Highways 37 and 135 (two-lane roads) from Eveleth to the North Gate access road to the site. This route would transport the materials through the towns of Canyon, Cotton, Biwabik, and Gilbert, near the town of Eveleth, and across rivers such as the Cloquet, Embarrass, St. Louis, and Whiteface. These routes already provide for the transportation of hazardous materials. Some emergency response services already would be available for these materials due to this activity. Thus, the additional risk posed by the transport of hazardous materials to the Plant and Mine Sites would be incremental.

The impact of an accidental release would depend on the location of the release in relation to populations and local activities, the quantity released, and the nature of the released material. The possibility of accidental release during delivery depends on factors such as skill and state of mind of the driver, type and condition of vehicle used for delivery, and traffic conditions, road type, and road conditions. Most of these factors are qualitative and even incidental. For the present evaluation, however, only quantitative factors are considered.

The probability of an accidental release of hazardous materials[1] during transportation was calculated using the Federal Highway Administration truck accident statistics model (Rhyne 1994) as presented in Table 4.12-2. According to these statistics, the average rate of truck accidents for transport along a rural interstate freeway is 0.64 per million miles traveled. For rural two-lane roads, the average truck accident rate is 2.19 accidents per million miles traveled.

1 The definition of hazardous materials, as per the Minnesota Hazardous Materials and Uniform HazMat Registration Program is, "a substance or material capable of posing unreasonable risk to health, safety, and property when transported in commerce, as determined by the US Secretary of Transportation."

Table 4.12-2 Material Transported during Construction, Operation, and Closure of the Project

	Rural Freeway						Rural Two Lane Road						
Material Transported	**No. of Truck Delivery**	**Haul Distance (Miles)**	**Accident Rate Per Million Miles Traveled**	**Calculated Number of Accidents**	**Probability of Release Given an Accident (%)**	**Calculated Number of Spill**	**No. of Truck Delivery**	**Haul Distance (Miles)**	**Accident Rate Per Million Miles Traveled**	**Calculated Number of Accidents**	**Probability of Release Given an Accident (%)**	**Calculated Number of Spill**	**Combined Total Estimated Release (Freeway and Rural Two- Lane)**
Diesel Fuel	17,800	60	0.64	0.68352	18.8	0.12850176	17,800	20	2.19	0. 77964	18.8	0.14657232	0.275
PAX FC	480	60	0.64	0.018432	18.8	0.003465216	480	20	2.19	0.021054	18.8	0.003952512	.007
Total						0.13						0.15	0.282

Note:
A compound event is any event that combines any two simple events. The assumption is:
P(A and B) = 0.275 x 0.007 = 0.002
P(A) + P (B) = 0.275 + 0.007 = 0.282
Thus
P(A or B) = [P(A) + P(B)] – [P (A and B)] = 0.282 – 0.002 = 0.28

The probability of a release or spill was based on accident statistics for liquid tankers carrying hazardous materials. These statistics indicate that on the average, 18.8 percent of accidents involving liquid tankers carrying hazardous materials resulted in a spill or release.

Using the accident and liquid tanker spill statistics, the probability evaluation indicates that the potential for an accidental release of liquids with truck transport during the life of the Project is less than one accident involving a spill of each of the materials considered. Specifically, there is about a 0.7 percent chance that an accident resulting in a release of PAX FC and a 27.5 percent chance that an accident resulting in a release of diesel fuel could occur over the entire 20-year life of the Project. Together, there is an approximately 28 percent chance that a single accident involving either one of these materials or both would occur at some point during Project operations.

Including the other shipments listed in Table 4.12-1 would incrementally increase the odds of a potential release of hazardous materials during a transport accident. The event of an accidental release could range from a minor oil spill on the Plant or Mine Sites where cleanup equipment would be readily available, to a severe spill during transport involving a large release of diesel fuel or other hazardous material. Some of the chemicals could have immediate adverse effects on water quality and aquatic resources if a spill were to enter a surface water body. However, considering the anticipated transport routes, the probability of a spill into a waterway is low. An alternative transportation route, shorter by about 17 miles, was rejected because of its close proximity to water bodies such as Wild Rice and Island Lakes. The selected transportation route for this evaluation is longer, but is farther away from waterbodies, so that in the event that a spill or a release of materials should occur, it could be managed in a timely manner to reduce the likelihood of a significant impact.

A large-scale release of hazardous liquids delivered to the site by tanker truck (7,500 gallon capacity), such as diesel fuel, acid, or other hazardous materials, could have implications for public health and safety. The location of the release would again be the primary factor in determining its importance. As indicated, the probability of a release anywhere along a proposed transportation route was calculated to be very low, and the probability of a release within a populated area would be even lower.

In addition to location, the potential hazard presented by the material released is a factor in determining the significance of a release. A qualitative evaluation of the materials to be shipped indicates that the probability of causing significant harm is low for most materials. For example, though ANFO is an explosive, it will only detonate under specific conditions such as when ignited with detonators, heat, or sudden shock wave in a confined space. Caustic soda is corrosive and can be fatal if ingested or has prolonged contact with the skin; however, in a spill situation, necessary response would be made to prevent or minimize any exposure from occurring, such as restricting site access and immediate containment and removal. In the event of a release during transport, the commercial transportation company would be responsible for first response and cleanup. Local and regional law enforcement and fire protection agencies also may be involved initially to secure the site and protect public safety.

In the event of an accident involving the release of hazardous material, 49 CFR requires that the carrier notify local emergency response personnel, the National Response Center (for discharge of reportable quantities of hazardous materials), and the Minnesota Duty Officer. PolyMet and its contractors would be required to comply with these and similar regulatory requirements.

Storage

The capacities of hazardous material storage tanks at the Project are listed in Table 4.12.1. Mobile tanker trucks may be used on site to fuel and maintain haul trucks, mobile equipment, and locomotives. The number of these trucks and their capacities would be based on Project-specific requirements. Tanks and vessels would be positioned on an approved containment surface with interior sumps to route any spilled process solutions to lined collection areas. In addition, hazardous materials would be unloaded on an approved containment surface with sumps to route any spills to lined collection areas. Some of the hazardous material storage tanks at the Mine Site would be double-walled. Mine Site hazardous material storage tanks without double walls and Plant Site hazardous material storage tanks would have secondary containment sufficient to hold at least 110 percent of the volume of the largest tank in the containment area. Waste materials such as used motor oils and spent hazardous materials would be shipped off site for recycling. In addition, fire assay wastes, including cupels, crucibles, and slag, would be shipped off site for recycling or disposal at a licensed facility. Certain materials may be stored on site for a period of time before shipment. These materials would be stored in compliance with safety storage requirements as dictated by both state and the federal requirements. The storage period would also be in compliance with any state and federal timeline stipulations. All such stored wastes would be labeled and dated for timeline inspection purposes.

Handling and Use

Over the life of the Project, the probability of minor spills of oils and lubricants would be relatively high. These releases could occur during operations, for example, as a result of a bad connection on an oil supply line or from equipment failure. Impacts of such minor spills could include contamination of surface waters and soils. However, spills of this nature would most likely be small, localized, and contained. The requirements for storage of oils and lubricants including the requirement for spill prevention control and countermeasure planning (SPCC plan) are found in the Oil Pollution Prevention Act (40 CFR 112) and Minnesota Statute Sections. Specific Minnesota Statutes include Prevention and Response Plans (section 115E.04), Response Plans for Trucks and Certain Tank Facilities (section 115E.045), Responses to Releases (section 115C.03) for petroleum tanks, and enforcement (section 115.071). A list of these plans is found in Table 4.12-3.

The main aim of the SPCC Plan is to develop strategies to prevent oil spills from reaching state and U.S. waters. An SPCC Plan is thus specific to each project and facility, providing site-specific information such as a description of facilities, storage information, preventative measures, response action, equipment, and contact information. An SPCC Plan also must provide information for routine facility inspections. Other incidents involving process solutions or flammable or explosive or other hazardous materials also could occur during mine operations.

To reduce the likelihood of incidental spills of these materials at the Plant and Mine Sites, preliminary SPCC documents have been prepared for both the mine and the process facility. The plan is developed to identify potential emergencies that may arise during operation of project facilities or an activity on the premises of a project. The plan establishes a framework to respond effectively to the identified potential emergencies. The SPCC may include situations involving hazardous materials. In addition to the SPCC, a Hazardous Materials Management Plan would be prepared. This plan would be a framework or mechanism for handling, storage and disposal of materials that are used or generated so that they do not cause harm or impact the environment adversely.

The SPCC plan would include procedures, methods, equipment and other requirements to prevent discharges of oil from facilities and to contain such discharges. The SPCC Plan would also contain a detailed, facility-specific, written description of how a facility's operations comply with the requirements of the Oil Pollution Prevention regulation (40 CFR Part 112). The SPCC plan would address measures such as secondary containment, facility drainage, dikes and barriers, sump and collection systems, retention ponds, curbing, tank corrosion protection systems, and liquid level devices. An SPCC Plan must be certified by a Professional Engineer (PE) that:

- The SPCC Plan is adequate for the facility;
- Technical standards have been considered;
- Inspections and tests are adequate for the facility; and
- The SPCC Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry practice.

Completion of an SPCC Plan that would allow PE certification is not possible for the Project until construction has been completed. However, a preliminary SPCC Plan, including a site map for the Project, has been prepared (ER04, PolyMet 2007; ER05, PolyMet 2007). The preliminary SPCC Plans were prepared in accordance with the requirements set forth in 40 CFR 112. Since the Project would have less than 1,000,000 gallons of tank capacity on site it falls under these rules and regulations. The policies and procedures set forth in this document, and a separate PolyMet Standard Procedure for Storage Tank Management, would be prepared to comply with Minnesota State Law, chapter 7151, Aboveground Storage of Liquid Materials.

The SPCC Plan would be finalized and certified by a PE as required, when petroleum storage and handling facilities have been constructed. Based on current planning and information, the SPCC Plan would need to address at least the following areas or activities involving petroleum oil:

- A truck fueling station;
- Remote fueling activities (i.e. at the equipment operating location);
- ASTs;
- Oil filled equipment;
- Locomotive fueling (at Area 2); and
- A gasoline fueling station (at the main gate).

The fueling station would consist of an enclosed building for fueling, including floor drain sumps and holding tanks for collection of spills. The holding tanks would be cleaned out as needed by a contractor with appropriate certification and/or license and transported to a recycling, treatment or disposal facility. One station normally would consolidate all rubber tired equipment (truck, front end loaders, rubber tired dozers, etc.) and fueling activities. This equipment also may be fueled in place by fuel tankers (remote fueling). Portable spill clean up kits would be available at the truck fueling station and on the fuel tankers. Remote fueling normally would be conducted for equipment located within mine pits and at material stockpiles (e.g., front end loaders and bulldozers). Standard operating procedures, including spill response plans, would be prepared and associated training would be conducted for fueling operations. Equipment would not be left unattended during fueling operations. When possible, remote fueling should not be performed near sensitive areas where if a release were to occur, surface water could be impacted. At final design stage an updated version of the current SPCC plan would be prepared for the Project facilities to address specific spill responses and cleanup, release notifications, etc. For oil-filled equipment, an appropriate containment system would be constructed so that any discharge from a primary containment system would not escape the containment system before cleanup occurs. Alternatively, facility procedures and a contingency plan would be established and documented that would require inspections or a monitoring program to detect equipment failure and/or a discharge. ASTs would be located at the truck fueling station where fuel storage would meet secondary containment standards. The tanks would have either a containment dike with a membrane or a concrete enclosure to contain leaks or spills. As previously indicated, double-walled ASTs would not require secondary containment.

The SPCC documents along with manufacturer MSDS sheets would be available in all areas where hazardous materials are expected to be used or produced and at all areas of fuel and lube oil storage. These plans include procedures for evacuating personnel, maintaining safety, cleanup and neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation. Proper implementation of the SPCC is expected to minimize the impacts associated with any potential release of hazardous materials.

Table 4.12-3 Hazardous Material Management Plans

Plans	Applicable Statute	Materials/Applications
SPCC Plan	EPA 40 CFR 112	Oil Spills
Hazardous Materials Management Plan	EPA 40 CFR 260 – 279 DOT 49 CFR	Handling, storage, disposal of oils, chemicals, fluids, other wastes. Transportation of hazardous materials.
Hazard Communications (HazCom) Standards	MSHA Rule 30 CFR Part 47	Evaluation of the hazards of chemicals mines produce or use and the provision of information to miners.
Emergency Response Plan	29 CFR 1910.120	Hazardous material release response guidance.
Spill Response Plan	29 CFR 1910.120/CAA Section 112 Minnesota Statute Chapter 115	General guidance Minnesota state guideline for responding to spills and releases.

Mitigation of hazardous material release would follow the principle of prevention, minimization and treatment. Prevention would be achieved when any hazardous material is avoided, where possible, by replacing it with a substitute material that is not hazardous. Since this is not possible in most cases, precautions would be taken to keep the release and the potential risk of exposure to a minimum. Any accidentally released hazardous material would be treated quickly and in accordance with the SPCC plan.

In addition, the mitigation process would include the following:

- Hazardous Materials Management Plan – with communication and training programs;
- Overfill Protection Procedures;
- Provision for Secondary Containment;
- Establishment of Leak Detection System;
- Preventative Inspection and Maintenance Procedures; and
- Emergency Response Plan.

These measures would be designed to ensure that accidental releases are prevented or minimized, and when they do occur they are responded to quickly and properly.

The monitoring activities proposed for prevention of incidental releases, mitigation or quick removal of the effects, if hazardous materials are released, include:

- Regular visual inspection of storage containers and facilities;
- Inspection of vessels for leaks, drips or loss content of containers;
- Verification of locks, emergency valves and other safety devices, protective equipment and floors;
- Regular checks on the operability of emergency systems;
- Periodic Awareness training for employees;
- Keeping MSDS sheets at visible locations for easy access at all times; and
- Regular monitoring of surface and ground water quality.

Monitoring would be an integral part of the hazardous material management process at the site.

4.12.3.2 No Action Alternative

The No Action Alternative would involve the remediation of historic potential releases. Upon the purchase of a portion of the site, 29 identified AOCs were accepted. Of these, several have already been closed or have received a no further action letter from the MPCA (see Table 4.1-9). For those remaining, additional investigation would be required to determine whether or not they require further action. The MPCA VIC program would be used to oversee the remediation activity for potential historical releases.

The No Action Alternative presents an environmental benefit of no additional hazardous material issues due to the lack of operations as compared to the Proposed Action during its 20 year project life. For the long term, however, no significant environmental benefit would be realized as compared to the Proposed Action, as both historic and operational releases would be addressed.

4.12.3.3 Mine Site and Tailings Basin Alternatives

The Mine Site and Tailings Basin Alternatives would have similar requirements for hazardous material transportation, storage, and handling as the Proposed Action. Therefore, these alternatives would have potential effects similar to those described for the Proposed Action.

4.12.3.4 Potential Mitigation Measures

This analysis did not identify any adverse effects from hazardous materials used by the Project, therefore, no mitigation measures are proposed.

4.12.4 Cumulative Effects

The release of any hazardous materials would be accidental and localized, and cumulative effects could not be predicted. In general, potential cumulative effects related to the transportation, storage, handling, use and disposal of hazardous materials are generally captured in the evaluation of potential water resources cumulative effects (Section 4.1.4).

4.13 GEOTECHNICAL STABILITY

While not a specific natural or cultural resource like those discussed in 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 existing mining facilities on site.

4.13.1.2 Plant Site

At the Plant Site, the existing brownfield LTVSMC flotation tailings basin is inactive and undergoing reclamation. Geotechnical investigations of this tailings basin (Sitka 1995 & 1997) indicate a significant portion of the peat and clay soils under the dam have the potential to develop instability under certain loading conditions. There are also layers of loose saturated slimes (fine silty tailings) within the LTVSMC stored tailings material that extend from the central portion of Cell 2E northward and connect with the perimeter embankment, which are subject to liquefaction under certain conditions and therefore may create instability of the perimeter dam. In addition, several seeps occur along the toe of the northern and southern embankments (see Sections 3.1 and 4.1).

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 (RS49, Golder 2007) are reasonable, although the vertical infiltration (seepage) rate for the

Category 1 and 2 overburden stockpile may be higher than predicted. Uncertainty in liner leakage infiltration rates were reviewed in Section 4.1 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 would occur during permitting to ensure that the proposed construction meets acceptable design standards.[1]

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 lower 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. The lower factor of safety in this zone is the reason for reviewing and selecting the mitigation measures described below.[2]

Review of proposed Hydrometallurgical Residue Facility preliminary designs (RS28T, 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 would occur during permitting to ensure that construction meets acceptable design standards.[3]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

1 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.

2 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.

3 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 would 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.[4]

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 rock stockpiles. However, typical liner designs and materials are proposed and no change in liner integrity or stockpile stability is anticipated. Further design and analysis would occur during permitting to ensure that construction meets acceptable design standards.[5]

4.13.3.4 Tailings Basin Alternative

Increased rock buttressing designs prepared for the northern outer embankment side slope of the existing LTVSMC Cell 2E tailings embankment would increase the geotechnical stability of the NorthMet Tailings Basin to within an acceptable margin of safety. Further investigations, design and analysis would occur during permitting to ensure that construction meets acceptable design standards, including: criteria regarding material characteristics and properties, disposal systems and methods, investigation techniques, facility analysis and design, hydrologic/hydraulic procedures, construction objectives and inspection, performance evaluation and redesign

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

4 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.

5 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.

considerations to insure geotechnical stability and satisfy the geochemical and other water quality objectives for the project.[6]

4.13.3.5 Mitigation Measures

Mine Site

If during permitting, at which time a greater level of design detail would be available, the final designs and analyses suggest risks associated with waste rock stockpile liner system integrity, mitigation measures (e.g., modifying the liner materials, installation methods, seepage collection systems) would be analyzed.

Also during permitting, if stockpile slope stability concerns are identified, mitigation measures (e.g., reduced heights, bench widths to reduce side slope angles) would be analyzed and any increased impact on wetlands would be assessed.[7]

Tailings Basin

The Tailings Basin Alternative incorporates mitigation measures identified to improve the Proposed Action design (see Section 3.2). While many other mitigation measures were considered but determined to be less effective, they would be available for reconsideration during permitting. In addition, a Dam Break analysis and risk assessment is recommended by the MnDNR 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 further increasing the rock buttress and dewatering of LTVSMC tailings slimes layer (e.g. using sand drains), would be evaluated.[8]

4.13.4 Cumulative Effects

No cumulative effects were identified for Geotechnical Stability.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

6 The Tribal cooperating agencies' position is that this approach is that the analysis must be conducted prior to permitting and included in the DEIS.

7 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.

8 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.

4.14 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, which was recommended by the MEQB as providing "the best source of guidance on cumulative impacts" (MEQB 1998). The CEQ guidelines acknowledge that while "in a broad sense all the impacts on affected resources are probably cumulative," it is important to "count what counts" and narrow the focus of the analysis to important national, regional, and local issues. While the CEQ recommends this be done through scoping, they also caution that "not all potential cumulative effects issues identified during scoping need to be included" in an EIS, but only those effects with direct influence on the Project and Project decision-making.

The methodologies recommended in the CEQ guidance document were used by the USEPA in their *Protocol to Assess Expanded Cumulative Effects on Native Americans* (2007). Therefore, the 1997 CEQ guidance document was used in this DEIS to assess the potential cumulative impacts of the proposed NorthMet Project in combination with other past, present, and reasonably foreseeable future actions. The geographic scope of analysis varies dependent upon the resource under discussion (e.g., water resources, air quality, uniquely-affected communities). The specific geographic scope for each resource is further discussed within the appropriate subsection of this analysis.[1]

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 ecoregion surrounding the Project. In addition, this section also

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[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 natura and cultural resources.

discusses the influence of these synergistic effects on uniquely-affected communities in the region.[2]

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 SDD (October 25, 2005) identified 12 resource-specific areas of concern related to cumulative effects. Table 4.14-1 provides a summary of the resource-specific concerns identified during scoping, and the spatial and temporal scales considered in this

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Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] 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.
- 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.

cumulative effects analysis. For those resource areas not identified in this section, no cumulative effects were identified.[3]

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 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 and Embarrass River Watersheds	Historic conditions from the 1930s to current. Future conditions through the extent of future effects from all reasonably foreseeable projects.
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.[4]
Streamflow and Lake Level Changes	Partridge River (including Colby Lake), Embarrass River, including consideration of downstream effects on the St. Louis River	2004 conditions (inclusive of historic influences) through operation and post closure (independent scenarios)
Water Quality Changes	Partridge River (including Colby Lake), Embarrass River, including consideration of downstream effects on the St. Louis 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 Final SDD)
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 Final SDD)

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[3] 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 resource 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.

[4] It is the Tribal cooperating agencies position that some mine features (e.g. pit lakes) would become permanent features of the landscape. Therefore post closure impacts should also be included in the analysis.

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).[5]

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, when combined with past, present, and future actions, would increase emissions, but would still cumulatively comply with the Federal and state increment limits. Therefore there would be no significant cumulative effect on Class II areas.
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, when combined with other past, present, 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 limits. Therefore, there would be no significant cumulative effect.
Ecosystem Acidification Resulting from Deposition of Air Pollutants	Air Quality (Section 4.6)	The Project, when combined with past, present, 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 would result in no significant adverse cumulative effect.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[5] 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.

Cumulative Effect Subject Area	Section in DEIS	Cumulative Effects Summary
Mercury Deposition and Bioaccumulation in Fish	Fish and Macroinvertebrates (Section 4.5)	The Project, when combined with past, present, and future actions, would add new mercury emitting sources. The NorthMet Project would be subject to the implementation plan for the mercury TMDL, requiring a plan to implement best controls reducing mercury emissions by at least 90% and equivalent emission reductions within the state because emissions would exceed 3 lbs/yr. The Project is expected to meet the Great Lakes mercury standard for surface water discharges of 1.3 ng/L for all alternatives. The Proposed Action has the potential to promote mercury methylation by releasing seepage with elevated sulfate concentrations to “high risk” situations. The Tailings Basin Alternative would minimize these discharges.
Visibility Impairment	Air Quality (Section 4.6)	The Project, when combined with past, present, 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, there would be no significant cumulative effect on visibility.
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 10 to 25% of the known populations of these species. The ETSC plant species known to occur in the Project area exhibit preferences or tolerance for disturbed sites and therefore would likely not experience adverse cumulative effects for the Project and past, current, and future projects.
Loss of Wetlands	Wetlands (Section 4.2)	The Project, when combined with past, present, and reasonably foreseeable future actions, would account for an approximately 1.0 to 3.4% loss in wetland area within the Partridge and Embarrass River watersheds; however, over 95% of the historic wetlands in the Partridge and Embarrass River watersheds would remain for the foreseeable future. Some wetland mitigation would occur on-site; however, most would be outside of the watershed and Ceded Territory leading to a net loss of wetland function within these areas.[6]
Loss or Fragmentation of Wildlife Habitat	Wildlife (Section 4.4)	Largest impact is due to forestry, which represents a temporary habitat conversion as opposed to the habitat loss from mining. Older forest and conifer habitat would increase for those species requiring older forests and forests with a significant conifer component, and would decrease for species that utilize young forests and non-forested habitats. Mining in general, and the Project in specific, would contribute to the cumulative effect on wildlife habitat, but it would be temporary (until Closure is completed) and not expected to be significant.
Wildlife Travel Corridors	Wildlife (Section 4.4)	Impacts from new and future projects are anticipated to 10 of the 18 remaining wildlife travel corridors ranging from potential loss to impairment of the corridors. These impacts should be considered significant; however, relative to the impacts from other reasonably foreseeable projects, the contribution of the NorthMet project to cumulative effects on wildlife corridors would be minor.[7]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[6] 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 that flaws in the wetland section have been addressed.

[7] 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.

Cumulative Effect Subject Area	Section in DEIS	Cumulative Effects Summary
Streamflow and Lake Level Changes	Water Resources (Section 4.1)	**Partridge River:** The Project, when combined with past, present, and reasonably foreseeable future actions, would reduce flows in the Upper Partridge River and contribute to an increase in the frequency and duration of low flows in the Lower Partridge River, depending on the timing of other mine dewatering activities, but these effects are not expected to be significant.[8]
		Embarrass River: The Project, when combined with past, present, and reasonably foreseeable future actions, would have negligible cumulative effect on stream flow in the Embarrass River and water levels in downstream lakes. It should not result in any significant effects on river geomorphology from increases in average or high flows and the slight (~2%) reduction in low flows under the Tailings Basin Alternative would generally offset increases in flows by other actions.
		St. Louis River: In general, the activities within the Partridge River watershed are expected to reduce its flow contribution to the St. Louis River, while activities in the Embarrass River watershed are expected to increase its flow contribution to the St. Louis River by approximately the same level of magnitude. There could be individual years, depending on the operations of specific mines, which could result in increases or decreases in flows in the St. Louis River, but these effects are not expected to be significant.
Water Quality Changes	Water Resources (Section 4.1)	**Partridge River:** The Project, when combined with present and reasonably foreseeable future actions, would degrade water quality in the Partridge River, but would still comply with all surface water standards. These activities would contribute to a further increase in sulfate levels, although Project contributions would be minor. The Lower Partridge River has relatively few riparian wetlands and no downstream lakes, and therefore is expected to contribute little to the cumulative effect on mercury methylation.
		Embarrass River: The Project, when combined with present and reasonably foreseeable future actions, would degrade water quality in the Partridge River, but would still comply with all surface water standards. These activities are predicted to increase average sulfate concentrations in the Embarrass River, which would attenuate as it flows downstream through the Embarrass chain of lakes. [9] The increased sulfate levels could increase mercury methylation in the wetlands north of the Tailings Basin and downstream in the Embarrass River,(if sulfate is still a limiting factor), and therefore have a cumulative effect on downstream lakes already on the 303(d) list. The Tailings Basin Alternative options would redirect the seepage away from the Embarrass River and not contribute to a cumulative effect on downstream lakes already on the 303(d) list.[10]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[8] Tribal cooperating agencies strongly disagree. As detailed in section 4.1, the available data and analysis is insufficient to make this claim. This cumulative impact analysis is incomplete.

[9] 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.

[10] It is the Tribal cooperating agencies position that the cumulative effects on the Embarrass River could be perpetual.

Cumulative Effect Subject Area	Section in DEIS	Cumulative Effects Summary
		St. Louis River: The present and reasonably foreseeable future actions would incrementally increase sulfate concentrations in the St. Louis River, but are not expected to result in significant increases in methylmercury concentrations as the St. Louis River has few riparian wetlands and no lakes for over 100 miles downstream of the confluence with the Embarrass River.
Economic Impacts	Socioeconomics (Section 4.10)	The Project, when combined with past, present, and future development along the Iron Range, would increase regional employment and spending, and thereby have a beneficial effect 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 cumulatively affected resource 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 all of St. Louis County and the 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, contribute to a regional nonattainment situation, or violate state air quality regulations. A detailed discussion of these standards can be found in Section 4.6. The Clean Air Act and standards promulgated pursuant to the Act 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, present, and future actions would have no significant cumulative effect on the regional airshed. Relative to mercury deposition and ecosystem acidification, the region is expected to experience a cumulative decline in 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.

In general, there are no analytical or modeling tools to reliably evaluate the cumulative effects from a particular project's greenhouse gas emissions on natural ecosystems and human economic systems in a given state or region. However, the Project and other ongoing and future actions would generally increase the CO_2 and other GHG emissions in the atmosphere, which may contribute to potential effects on climate change. In addition, the predicted impacts to wetlands, forests, and other vegetative cover types are likely to affect the carbon storage and sequestration abilities of these ecosystems, thereby exacerbating the impact. The GHG reduction measures, wetland mitigation plan, and mineland reclamation plan for the NorthMet Project would reduce the intensity of these impacts by reducing GHG emissions and offsetting the loss of carbon storage and sequestration capacity in the natural ecosystem; however, the overall net cumulative effect would result in an increase in the emission of CO_2 and other GHGs.

Watershed

Hydrology

The cumulative effects of past, present, and reasonably foreseeable future actions on the hydrology of the Partridge, Embarrass, and St. Louis rivers would not be expected to impact river geomorphology under high flows. The frequency and duration of low flows in the Lower Partridge River prior to the St. Louis River confluence, however, could increase and could affect the downstream aquatic community. Significant adverse effects are not expected because the magnitude of low flows is not expected to be reduced because of pumping from Whitewater Reservoir. Low flows in the Embarrass River would increase under the Proposed Action, or decrease slightly under the Tailings Basin Alternative, but should not result in any significant adverse effects on the aquatic community under either alternative. In general, the activities within the Partridge River watershed are expected to reduce its flow contribution to the St. Louis River, while activities in the Embarrass River watershed are expected to increase its flow contribution to the St. Louis River by approximately the same level of magnitude. There could be individual years, depending on the operations of specific mines, which could result in increases or decreases in flows in the St. Louis River, but these effects are not expected to be significant.

Water Quality

The water quality of the Partridge and Embarrass Rivers is generally good, although comparison to undisturbed streams in the region indicate that water quality has been degraded over time, presumably by mining activities and municipal/industrial wastewater and stormwater discharges. Nevertheless, water quality generally meets surface water standards and the rivers are not on the Minnesota 303(d) list of impaired waters. Several lakes on the Partridge and Embarrass Rivers, however, are listed on the 303(d) list because of mercury in fish tissue impairment.

The NorthMet Project is expected to meet all surface water quality standards under all flow conditions for all mine years in the Partridge and Embarrass rivers. The Project would, however, 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 below surface water standards. Therefore the cumulative effects analysis for the NorthMet Project focused on mercury (only parameter on the 303(d) list) and sulfate (because of its relationship with mercury methylation and wild rice)..

The Project, in combination with other present and reasonably foreseeable future actions, would increase sulfate concentrations in both the Partridge and Embarrass Rivers, which in turn would result in a minor increase in sulfate concentrations downstream in the St. Louis River. This increase in sulfate concentrations is principally of concern in terms of potential effects on wild rice and mercury methylation, as the predicted concentrations in surface waters are well below the 250 mg/L standard that applies to Class 1B waters such as Colby Lake.

Some evidence suggests that increased sulfate concentrations could impact waters that contain wild rice. Recent field studies identified several wild rice areas along the Partridge and Embarrass Rivers. Wild rice is clearly found in waters with elevated sulfate concentrations such as the Lower Partridge River (average measured concentration of 149 mg/L), but it less clear what effect elevated sulfate concentrations have on the health and productivity of natural wild rice, or what effect further incremental increases in sulfate concentrations would have.

Virtually all dispersal of mercury in the environment occurs in the inorganic form, but nearly all of the mercury accumulated in fish tissue (>95%) is organic mercury resulting from the methylation of mercury by sulfate-reducing bacteria. This mercury methylation process can be stimulated by increased sulfate concentrations in aquatic systems where sulfate is limiting. The MPCA (2006) recommends avoiding discharges of sulfate to high risk situations for mercury methylation, 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 cumulative effects of past and present activities have resulted in a significant increase in sulfate concentrations from baseline conditions in the Lower Partridge River. This is expected to increase further as a result of the NorthMet and Mesabi Nugget Phase II projects. These projects would discharge directly to the Lower Partridge River (at least for the NorthMet Tailings Basin Alternative), which is not considered to be a high risk area for mercury methylation. Therefore, the NorthMet Project is not expected to contribute to cumulative effects on mercury in water or fish tissue in the Partridge River watershed.

The Embarrass River would be considered a high-risk situation for sulfate discharges. Past and ongoing activities in the Embarrass River watershed, primarily the Area 5 NW pit overflows, have resulted in historically elevated sulfate levels in the Embarrass River, although these effects are generally attenuated in the Embarrass River chain of lakes. In terms of the reasonably foreseeable future activities, the NorthMet Proposed Action would result in a significant increase in seepage from the Tailings Basin,which would contain elevated sulfate concentrations. This seepage is expected to upwell into the wetland complex north of the Tailings Basin and eventually flow to the downstream chain of lakes on the Embarrass River (four of which are on the 303(d) list for mercury in fish tissue impairment), both of which would be considered high risk situations for mercury methylation. It is unclear whether sulfate would still be a limiting factor for mercury methylation in this area that already has elevated sulfate concentrations, but PolyMet is conducting additional monitoring to help answer this question. The Tailings Basin Alternative would avoid these high risk areas by discharging most Tailings Basin seepage to the Partridge River downstream of Colby Lake (not a high risk area) and would reduce sulfate loading below existing conditions in the Embarrass River watershed and therefore, would not contribute to cumulative effects on mercury concentrations in water or fish tissue in the Embarrass River watershed.

The activities included in this cumulative effects assessment have the potential to increase sulfate concentrations in the middle segment of the St. Louis River between the confluence with the Embarrass River and Knife Falls Dam; however, there are no significant wild rice stands, relatively few riparian wetlands, and no lakes that would be anticipated to lead to significant uptake of sulfate, or increase the mercury methylation risk. Overall, the Project is not expected to contribute significantly to cumulative effects on mercury in the St. Louis River.

Ecoregion

The 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 federal, state, and local public lands in northeastern Minnesota (including the Mine Site) currently provide large tracts of natural vegetative cover, including wild rice, and habitat for endemic aquatic and terrestrial wildlife species such as moose. The development of past and current mining and forestry operations throughout the Mesabi Range has led to a historic reduction in natural vegetative cover (including mature forests) and habitat fragmentation throughout the region. Future activities (including the Project) would contribute to further declines in habitat age, availability, and connectivity. In addition, long-term reclamation plans following cessation of mining operations have historically included the use of non-native, invasive species, which have further contributed to a decline in continuous, native habitat tracts in the region. The use of a native seed mix (provided it meets reclamation goals and requirements) would mitigate the impacts to the long-term forest community such that it would mimic historic, natural conditions. In general, vegetative cover in the Arrowhead Region over the past century has seen a reduction in the component, size, age, and diversity of conifer forests, primarily due to forestry which maintains a younger, more uniform forest structure, and also mining influences.

Despite these impacts, northeastern Minnesota still retains large tracts of undisturbed habitat and recent studies suggest that Minnesota’s forests are recovering. Total forest cover (albeit a younger stand age) has returned to 1890 levels and includes a large conifer component, although not all conifer types (e.g., Jack Pine) have increased to the same extent (see Section 4.4.4). As a result, wildlife species that were harmed by past forest changes have been favored by recent forest changes in the Arrowhead Region. Additionally, more than 95% of the historic wetlands within the Partridge and Embarrass River watersheds are still intact, despite the impacts of this and other projects.

Habitat connectivity also presents concerns for wildlife movement as relatively continuous mining operations and/or habitat loss could pose a barrier for wildlife, which move less frequently between habitat patches when passage is blocked by mining operations, roads, and urban development. The NorthMet Project and other current and future actions may affect wildlife movement by blocking or encroaching into 12 of the 18 mapped wildlife corridors, affecting adjacent habitat that may make these corridors less valuable, and increasing traffic along new or existing roads through the corridors. These impacts vary from potential direct losses to minor fragmentation within, or adjacent to, the corridors. All of these impacts would combine to impair wildlife accessibility, although it should be noted that some impairments would still allow wildlife passage, albeit through degraded habitat conditions until completion of habitat reclamation activities.[11] It should be noted that stockpiles and other mine features that

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[11] 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.

are revegetated and reclaimed following operations would not constitute permanent barriers to wildlife movement. Cumulatively, these impacts should be considered significant; however, relative to the impacts from other reasonably foreseeable projects, the contribution of the NorthMet project to cumulative effects on wildlife corridors would be minor.

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. Most of the affected ETSC species are disturbance tolerant and impacts would not be significant.

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 are the Native American tribes within the 1854 Ceded Territory in northeastern Minnesota. These tribes have cultural ties to the natural landscape that would potentially be uniquely impacted by the Project. 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, or spiritual practices.

The Native American tribes within the 1854 Ceded Territory have used lands within the Ceded Territory for traditional cultural purposes including, wild rice harvesting and moose hunting. Although there is little documented evidence of tribal harvesting of wild rice in the Partridge and Embarrass Rivers, field studies have identified wild rice areas along the Upper Partridge River, along the Lower Partridge River near County Road 110, and in the Embarrass River chain of lakes. Moose also 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 and ongoing and future mining activities would be unlikely to encourage an increase in moose densities relative to the rest of northeastern Minnesota.[12] Consultation between the USACE and Native American tribes to identify an indirect APE and further characterize historic properties of religious and cultural significance to the Ojibwa 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 (the USFS roads, however, are available to the public) and would continue to be restricted in the absence of the Project. 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

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[12] The Tribal cooperating agencies note that 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 has dropped to critical levels. The Project is proposed 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.

directly support wild rice or high-density moose populations, which are common tribal uses of public lands. Nevertheless, the Project and other future and ongoing projects in the region would lead to the loss of public access within the 1854 Ceded Territory, which represents an adverse effect to the tribes.[13] For the NorthMet Project, the USFS and PolyMet have been exploring the feasibility of a land exchange for the Mine Site area. The USFS has identified approximately 6,700 acres of National Forest land to exchange to PolyMet for yet to be determined non-federal land. PolyMet intends to propose private lands within the 1854 Ceded Territory; therefore, the lands would be available to the affected tribes, thereby reducing the overall cumulative effect of the Project and other ongoing and future actions on tribal access to public lands within the 1854 Ceded Territory.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[13] 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.

5.0 COMPARISON OF ALTERNATIVES

Minnesota law (Minnesota Statutes, section 116D.04 and section 116D.045; and Minnesota Rules, part 4410.0200 through part 4410.7500) requires that an EIS include a discussion and comparison of the impacts of the alternatives, including 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 of this DEIS describes the alternatives and the resource-specific sections of Chapter 4 describe the reasonable mitigation and monitoring measures considered during the scoping process and DEIS development. This chapter compares the impacts of 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, Mine Site Alternative, 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 seepage. Under the Proposed Action, the stockpiles containing Category 2, 3, and 4 waste rock and lean ore 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, the Category 2, 3, and 4 waste rock and Category 3 lean ore would permanently be disposed as backfill in the East Pit and submerged beneath groundwater to reduce oxidation. 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 to capture Tailings Basin seepage; test a permeable reactive barrier (PRB) along the northern toe of the Tailings Basin to potentially treat seepage during Post-Closure; extend the partial dry cap over the Tailings Basin embankment 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. Under the No Action Alternative, the Project would not occur, the Plant Site would be closed pursuant to the existing Cliffs Erie closure plan, and only logging and other activities allowed under the Superior National Forest Management Plan would occur at the Mine Site.

Table 5.1-1 compares the anticipated impacts of the Proposed Action with the Mine Site Alternative, Tailings Basin Alternative, and No Action Alternative. Mitigation measures that address some or all of the anticipated impacts are described in Section 5.2 below.[1]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[1] 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.

Table 5.1-1 Comparison of the Anticipated Impacts for Each 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 until Post-Closure (i.e., overflow of the West Pit around Mine Year 65).[2]	Same as the Proposed Action[3]	This alternative applies to water management at the Tailings Basin, and therefore would have no effect on groundwater levels at the Mine Site.	No effect
Groundwater quality at the Mine Site	Antimony, manganese, nickel, and sulfate predicted to exceed groundwater evaluation criteria, potentially for long term.	Antimony concentrations predicted to exceed groundwater evaluation criteria, but may not when sorption and use of the concentration cap from the contaminated humidity cells are accounted for.	This alternative applies to water management at the Tailings Basin, and therefore would have no effect on groundwater quality at the Mine Site.	No effect
Flows in the Upper Partridge River	Reduce average flow by approximately 1.5 cfs (8%). Minimal reduction in absolute annual 7-day low flow (~0.1 cfs, or about 22%). No significant effect on river morphology or 100-year floodplain.[4]	Same as the Proposed Action[5]	This alternative applies to water management at the Tailings Basin, and therefore would have no effect on flows in the Upper Partridge River.	No effect

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[2] As stated in sections 4.1 and 4.2, Tribal cooperating agencies strongly disagree with this conclusion.
[3] As stated in sections 4.1 and 4.2, Tribal cooperating agencies strongly disagree with this conclusion.
[4] As stated in sections 4.1 and 4.2, Tribal cooperating agencies strongly disagree with this conclusion.
[5] As stated in sections 4.1 and 4.2, Tribal cooperating agencies strongly disagree with this conclusion.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Water quality in the Upper Partridge River	Water quality degraded, but all parameters predicted to meet all surface water quality standards at all locations during 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 and exceedances could be mitigated.[6]	Same as the Proposed Action, although water quality improved relative to the Proposed Action for most parameters.[7]	This alternative applies to water management at the Tailings Basin, and therefore would have no effect on water quality in the Upper Partridge River.	No effect
Water levels in Colby Lake and Whitewater Reservoir	Negligible increase (0.03 ft) in average water level drawdown and improvement in maximum annual fluctuation and % days below critical elevation at Colby Lake. Water level fluctuations and average drawdown would increase at Whitewater Reservoir relative to existing conditions, but would be no greater than when LTVSMC was operating.	Same as the Proposed Action	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 relative to the Proposed Action.	No effect
Water quality in Colby Lake and Whitewater Reservoir	Water quality degraded, but all parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.	Same as the Proposed Action, although water quality improved relative to the Proposed Action for most parameters.	This alternative applies to water management at the Tailings Basin, and therefore would have no effect on water quality in Colby Lake and Whitewater Reservoir.	No effect

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[6] Tribal cooperating agencies' position is that this is misleading. Pit water quality would exceed surface water standards for the foreseeable future.
[7] Tribal cooperating agencies position is that this is misleading. Pit water quality would exceed surface water standards for the foreseeable future.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Flows in the Lower Partridge River	Reduce average flows by as much 10.5 cfs (9%) and increase the frequency and duration, but not the magnitude, of low flows. Negligible effect on river morphology.	Same as the Proposed Action	Reduce average flow by between 3.4 cfs (3%) (Max Recycle Option) and 5.3 cfs (5%) (No Recycle Option), but should have negligible effects on river morphology.	No effect
Water Quality in Lower Partridge River	Water quality degraded, but all parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.	Same as the Proposed Action, although water quality improved relative to the Proposed Action for most parameters.	Discharge of between 1.1 cfs (Maximum Recycle Option) and 5.2 cfs (No Recycle Option) of Tailings Basin seepage pumped from vertical wells to the Lower Partridge River would meet all surface water quality standards during all flow conditions for all mine years, although it would significantly increase sulfate loadings and reduce the available assimilative capacity.[8]	No effect.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[8] Tribal cooperating agencies disagree. The wild rice sulfate standard would be exceeded.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Groundwater levels downgradient of the Tailings Basin	Groundwater seepage would exceed aquifer flux capacity resulting in significant seepage upwelling and wetland impacts.	This alternative applies to waste rock management at the Mine Site, and therefore would have no effect on groundwater levels downgradient of the Tailings Basin.	Pumping by vertical wells would reduce the amount of unrecovered NorthMet groundwater seepage by approximately 95% during operations and 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, but at a reduced level relative to existing conditions as Tailings Basin continues to dewater and reach a relatively steady state.
Groundwater quality downgradient of the Tailings Basin	Groundwater quality degraded, but seepage from the Tailings Basin would meet all groundwater evaluation criteria with the exception of aluminum, which is naturally found in elevated concentrations in the Project area.[9]	This alternative applies to waste rock management at the Mine Site, and therefore would have no effect on groundwater quality downgradient of the Tailings Basin.	Same as the Proposed Action, although groundwater quality is improved relative to the Proposed Action for most parameters.	Anticipate slight improvement in groundwater quality as Areas of Concern are investigated and remediated as appropriate.
Flows in the Embarrass River	Approximately 6% increase in average flow during operations and 1% decrease during Closure would have negligible effect on flows in the Embarrass River. Negligible effect on river morphology expected.	This alternative applies to waste rock management at the Mine Site, and therefore would have no effect on flows in the Embarrass River.	Approximately 2% (1.7 cfs) reduction in average flow reduced during operations and 2% (1.9 cfs) during Closure should have negligible effect on flows in the Embarrass River. Negligible effect on river morphology expected.	Approximately 2% (1.6 cfs) reduction in base flow as a result of gradually reduced seepage rate from LTVSMC Tailings Basin. Negligible effect on river morphology expected.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[9] Tribal cooperating agencies disagree. Existing contamination is not included in the groundwater quality analysis, therefore, impacts are not fully characterized.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Water Quality in the Embarrass River	Water quality degraded, but all parameters predicted to meet all surface water quality standards during all flow conditions for all mine years.[10]	This alternative applies to waste rock management at the Mine Site, and therefore would have no effect on water quality in the Embarrass River. .	Same as the Proposed Action, although groundwater quality is improved relative to the Proposed Action for most parameters.[11]	Potential slight improvement in water quality as Areas of Concern are investigated and remediated as appropriate.
Waters that Contain Wild Rice	Increase in hydrologic variability and about a 1 to 2 mg/L increase in sulfate concentrations under average flows in the Lower Partridge River, although sulfate concentrations are already elevated in this area (>100 mg/L). Negligible effect on seasonal hydrology of the Embarrass River, but a predicted increase in sulfate concentrations under average flows of 20 mg/L at PM-13.	Increase in hydrologic variability and about a 1 to 2 mg/L increase in sulfate concentrations under average flows in the Lower Partridge River, although sulfate concentrations are already elevated in this area (>100 mg/L). No effect on the hydrology or water quality of the Embarrass River.	Reduction in hydrologic variability, but a 1 to 9 mg/L increase in sulfate concentrations under average flows in the Lower Partridge River, although sulfate concentrations are already elevated in this area (>100 mg/L). Negligible effect on seasonal hydrology and negligible effect on average sulfate concentrations (<1 mg/L) in the Embarrass River.	No effects on hydrology or water quality in the Partridge River. Negligible effect on seasonal hydrology and a modest long-term improvement in sulfate concentration expected in the Embarrass River.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[10] Tribal cooperating agencies strongly maintain that the wild rice standard applies.
[11] Tribal cooperating agencies disagree. Existing contamination is not included in the groundwater quality analysis, therefore, impacts are not fully characterized.

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, but this impact could be mitigated if it would occur.	There is some uncertainty as to whether the West Pit overflow would meet the Lake Superior mercury standard, but this impact could be mitigated if it would occur.	70% reduction (relative to existing conditions) in NorthMet sulfate loading from Cells 1E/2E to high risk mercury methylation environments (i.e., wetlands and downstream lakes).[12]	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, creating what MPCA guidance describes as a "high risk situation" for mercury methylation, although at a slightly lower rate than under existing conditions.
Wetlands				
Direct Impacts	Direct impacts to approximately 804.3 acres at the Mine Site, 39.4 acres at the Plant Site and 10.5 acres along the transportation corridor, primarily consisting of coniferous and open bogs.	Direct impact to 796.7 acres of forested, scrub/shrub, and open water wetlands at the Mine Site. Elimination of some permanent surface stockpiles reduces the impacts at the Mine Site during Closure and Post-Closure by approximately 7.6 acres.	Direct impact to 41.2 acres of scrub/shrub and open water wetlands at the Tailings Basin. Additional impacts associated with construction of the seepage water discharge pipeline from the Tailings Basin to the Partridge River.	No effect. Historically-disturbed wetlands at the Plant Site would revert to natural hydrology quicker than under the action alternatives.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[12] 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.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Indirect Impacts	Indirect impact to 318.6 acres at the Mine Site due to wildlife fragmentation and hydrologic effects and potential indirect impacts to 349.3 acres north of the Tailings Basin due to seepage.[13]	Indirect impact to 318.6 acres at the Mine Site due to wildlife fragmentation and hydrologic effects.[14]	No indirect impacts north of the Tailings Basin because of the capture of seepage by the vertical wells and discharge to the Lower Partridge River.	No effect.[15]
Vegetation				
Cover Types	Loss of 269 acres of vegetative cover at the Plant Site and 1,454 acres of vegetative cover at the Mine Site 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 vegetative cover at the Mine Site during Closure and Post Closure by 33 acres.	Loss of an additional 45.4 acres of upland vegetation along the expanded water discharge pipeline right-of-way during the life of the pipeline. Following closure, the pipeline right-of-way would be allowed to revegetate.	Increased native species cover at the Plant Site following Closure.
Non-Native Invasive Species	Revegetation would introduce invasive, non-native species.	Same as the Proposed Action	Same as the Proposed Action for the Plant Site. Additionally, potential emigration of invasive species through natural migration and seed dispersal due to disturbance within the water discharge pipeline corridor.	Potential natural emigration of invasive species due to disturbance within the corridor.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[13] Tribal cooperating agencies disagree. As described in section 4.2, indirect impacts are likely to be greater.
[14] Tribal cooperating agencies disagree. As described in section 4.2, indirect impacts are likely to be greater.
[15] The tribal cooperating agencies disagree. The existing tailings basin effluent would continue to affect existing wetlands to the north.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
ETSC Species	Direct impacts to prairie moonwort (*Botrychium campestre*), pale moonwort (*B. pallidum*), least grapefern (*B. simplex*), neat spikerush, *(Eleocharis nitida*), lapland buttercup (*Rununculus lapponicus*), clustered bur-reed (*Spartinum glomeratum*), and Torrey's manna-grass (*Torreyochloa pallida*). Indirect impacts to pale moonwort, ternate grapefern (*B. regulosum*), least grapefern, floating marsh mallow (*Caltha natans*), neat spikerush, lapland buttercup, and clustered bur-reed due to changes in hydrology or other surface conditions.	Same as the Proposed Action.	This alternative applies to water management at the Tailings Basin, and therefore would have no effect on ETSC species only found at the Mine Site.	Direct impacts due to logging influence on habitat types. Indirect impacts due to natural succession influence on habitat types.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Wildlife				
Wildlife Habitat	Losses of 269 acres of wildlife habitat at the Plant Site and 1,454 acres of wildlife habitat at the Mine Site until completion of the reclamation actions (e.g., the life of the mine plus up to 40 years depending on cover type). Limited beneficial effect following Closure of the Plant Site.[16]	Similar to the Proposed Action; however, the elimination of some permanent surface stockpiles due to subaqueous disposal would reduce the loss of wildlife habitat at the Mine Site by 33 acres at Closure.	Same as the Proposed Action at the Plant Site.	Limited beneficial effect following Closure of the Plant Site, which would occur earlier relative to the Proposed Action. No effect at the Mine Site.[17]
ETSC Species	Potential loss of critical habitat and increased risk of vehicle strikes to Canada lynx and gray wolf (federally-listed threatened species) at the Mine Site.[18]	Same as the Proposed Action.	No significant effect.	Limited beneficial effect following Closure of the Plant Site, which would occur earlier relative to the Proposed Action. No effect at the Mine Site.[19]
Fish and Macroinvertebrates				
Water Quality	No significant effect. [20]	No significant effect.	No significant effect.[21]	No effect.[22]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[16] The tribal cooperating agencies' position is that characterization is incomplete.
[17] The tribal cooperating agencies' position is that no analysis is provided to justify this claim.
[18] The tribal cooperating agencies' position is that impact characterization is incomplete.
[19] The tribal cooperating agencies' position is that no analysis is provided to justify this claim.
[20] The Tribal cooperating agencies' position is that sulfate and mercury methylation impacts would increase.
[21] Tribal cooperating agencies disagree. Increased mercury methylation is likely due to the discharge of high sulfate tailings water.
[22] The tribal cooperating agencies' disagree. The existing tailings basin effluent would continue to affect existing wetlands and the Embarrass River.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Physical Habitat	No significant effect. Increased duration and frequency of low flows in the Lower Partridge River. Low flow rate would temporarily increase in the Embarrass River during operation.	Same as the Proposed Action.	Reduce water level fluctuations and maintain higher flows in the Lower Partridge River relative to the Proposed Action	No effect.
Mercury and Bioaccumulation	Potential increase in the availability of methylmercury to fish resulting from the release of sulfates in Tailings Basin seepage to MPCA-defined high risk areas (i.e., downgradient wetlands and the downstream Embarrass River chain of lakes).[23]	Same as the Proposed Action.	Reduce risk of methylmercury formation in wetlands north of the Tailings Basin and lakes along the Embarrass River by capturing Tailings Basin seepage and discharging it to the lower risk Partridge River.[24]	No effect.[25]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[23] The tribal cooperating agencies' reiterate the PCA's position that increased sulfate in the tailings basin seepage interactive with the wetland complexes would constitute a high risk mercury methylation scenario. The extent of this impact has not been characterized.
[24] Tribal cooperating agencies disagree. The reduction in methylmercury in the Embarrass River would be accompanied by an increase in the Partridge River.
[25] 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.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Air Quality				
	No significant effect; however, the Project would increase regional GHG emissions.	No significant effect; however, this alternative would result in the "double-handling" of waste rock so transportation emissions would be higher relative to the Proposed Action.	No significant effect.	No effect.
Noise				
	No significant effect.[26]	No significant effect.[27]	No significant effect.[28]	No effect.
Cultural Resources				
Historic/ Archaeological Resources	Adverse effects due to the demolition of the Concentrator Building and the facility railroad spur, which are NRHP eligible properties at the Plant Site. The Building and railroad spur would be documented in accordance with the Minnesota Historic Preservation Office procedures prior to demolition.[29]	Same as the Proposed Action.[30]	Same as the Proposed Action.	No effect.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[26] Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.
[27] Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.
[28] Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.
[29] Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.
[30] Tribal cooperating agencies disagree. The analysis and available data do not support this conclusion.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Tribal Use	Potential loss of access to public lands for tribal use due to the land exchange; however PolyMet intends to propose private lands within the 1854 Ceded Territory for exchange, which could offset the loss of access.[31]	Same as the Proposed Action.	Same as the Proposed Action.	No effect.[32]
Compatibility with Plans and Land Use Regulations				
	The reclamation plan proposes use of non-native, invasive species for replanting; however, with mitigation measures, the Project could be compatible with state and local land management plans.	Same as the Proposed Action.	Same as the Proposed Action.	No effect.
Socioeconomics				
	Beneficial effect: Local increase in employment, tax revenues, and spending. The local infrastructure can support the anticipated influx of workers; therefore, there would be no significant effect on community infrastructure. [33]	Same as the Proposed Action.	Same as the Proposed Action.	No effect.[34]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[31] The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion.
[32] 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.
[33] Tribal cooperating agencies' position is that this section fails to address negative impacts, and the conclusions are therefore unsupported.
[34] Tribal cooperating agencies disagree. The ongoing cost of cleanup of legacy contaminants should be addressed.

Resource	Proposed Action	Mine Site Alternative	Tailings Basin Alternative	No Action Alternative
Visual Resources				
	No significant effect.[35]	No significant effect.[36]	No significant effect.[37]	Limited beneficial effect following Closure of the Plant Site, which would occur earlier relative to the Proposed Action. No effect at the Mine Site.[38]
Hazardous Materials				
	No significant effect.	No significant effect.	No significant effect.	No effect.
Geotechnical Stability				
	The NorthMet Tailings Basin and hydrometallurgical residue facility embankments would have a low margin of safety due to fines and underlying soils in the existing LTVSMC Tailings Basin. Mine Site stability anticipated to be reviewed during permitting.	Same as the Proposed Action relative to the Mine Site.	Increased stability of the Tailings Basin embankment due to increased buttress. No effect at Mine Site.	Slight risk of slumping at the north toe of the Tailings Basin. No effect at the Mine Site.

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[35] The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion.
[36] The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion.
[37] The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion.
[38] The Tribal cooperating agency position is that the PDEIS does not contain any data or analysis that would support this conclusion.

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. These mitigation measures were analyzed, revised or eliminated, and additional mitigation measures were identified during the development of the DEIS. A summary of these potential mitigation measures is 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 alternatives (All). Refer to the resource-specific sections in Chapter 4 of the DEIS for a detailed description and the potential benefits of the measures. Note that these measures may be included as permit conditions, should a permit be issued.

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. This DEIS identifies some critical factors for monitoring. PolyMet would need to develop a comprehensive management plan for its stockpiles, tailings, and hydrometallurgical waste for permitting. PolyMet's proposed monitoring program would be refined if the Project moves forward to permitting, and may incorporate measures in Table 5.2-1.[39]

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[39] 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 the 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 spil 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 buffer thickness to 24 to 36 inches	PA, MSA	4.1.3.5
	Provide chemical modification of Category 3 and 4 waste rock and Category 3 lean ore stockpiles	PA, MSA	4.1.3.5
	Enhance the Category 1 stockpile liner	PA, MSA	4.1.3.5
	Revise 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
	Increase the backfill of the East Pit to allow for a geomembrane cover over the entire exposed Virginia Formation	PA, MSA	4.1.3.5
	Expedite flooding of the West Pit	PA, MSA	4.1.3.5
	Treat West Pit overflows by various methods, if needed	PA, MSA	4.1.3.5
	Provide stormwater management at the Plant Site to control runoff from the Processing Plant area	PA, TBA	4.1.3.5
	Use alternate embankment material at the Tailings Basin	PA, TBA	4.1.3.5
	Provide an enhanced bentonite cap at the Tailings Basin	PA, TBA	4.1.3.5
	Provide enhanced Tailings Basin geomembrane cap	PA, TBA	4.1.3.5
	Retain the seepage barrier to Second Creek after Closure	PA, TBA	4.1.3.5
	Install a PRB north of the Tailings Basin, if needed	PA, TBA	4.1.3.5
	Provide Tailings Basin seepage treatment prior to discharge, if needed	TBA	4.1.3.5
4.2 - Wetlands	Complete compensatory wetland mitigation on-site, at the Aitkin Site, Hinckley Site, and others as determined through the Section 404 permit process with the USACE	All	4.2.4.2
	Maximize the elevation of the Category 1 and 2 stockpile	PA, MSA	4.2.4.2
	Implement a wetland monitoring plan to identify any additional indirect effects on wetlands and provide compensatory mitigation, as needed [40]	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
	Fence/Flag 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
	Add organic amendments to the Tailings Basin	PA, TBA	4.3.3.5

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[40] The Tribal cooperating agency position is that the wetland monitoring plan should be developed and included in the DEIS.

Resource	Mitigation Measures	Applicability	Section in Text
4.4 – Wildlife	Vehicular prevention and avoidance techniques including speed limits and driver instructions for Dunka Road users	PA, MSA	4.4.3.5
	Limit access to the Mine Site during reclamation through signage, barriers, and berms to facilitate habitat restoration and wildlife use[41]	PA, MSA	4.4.3.5
4.5 - Fish and Macroinvertebrates	Develop a mercury monitoring plan for the Mine Site[42]	PA, MSA	4.5.3.5
4.6 - Air Quality	No specific mitigation measures are identified at this time; however, additional mitigation could be considered during permitting and operational monitoring, as necessary, including in-state equivalent reductions, cross-sector partnerships, product collections, public owned treatment works, and research.	All	4.6.3.5
4.7 - Noise	Adjust blast hole pattern and add delay weights to mitigate vibrations	PA, MSA	4.7.3.5
	Maintain air overpressure levels through delay weight reductions, appropriate stemming depth, use of shock tubes, and depth of burden	PA, MSA	4.7.3.5
	Avoid blasting during unfavorable atmospheric conditions	PA, MSA	4.7.3.5
	Blast on a consistent daily schedule	PA, MSA	4.7.3.5
4.8 - Cultural Resources	Develop recordation plan for the Concentrator Building and the facility railroad spur	PA, MSA	4.8.4.4
	PolyMet intends to propose private lands within the 1854 Ceded Territory for exchange with the USFS	All	4.8.4.4
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	All	4.10.3.5
4.11 - Visual Resources	Direct operating lights downward to shield light sources	All	4.11.3.5
4.12 - Hazardous Materials	No mitigation measures identified.	All	4.12.3.5

Position statements submitted by tribal cooperating agencies are footnoted as part of the process of documenting their differences of opinion with specific content and conclusions of the DEIS. See Section 1.6.1.

[41] Tribal cooperating agencies disagree. Barriers and berms could add to impacts on wildlife.
[42] The Tribal cooperating agency position is that the wetland monitoring plan should be developed and included in the DEIS.

Resource	Mitigation Measures	Applicability	Section in Text
4.13 – Geotechnical Stability	No specific mitigation measures identified at this time; however, additional mitigation to be considered during permitting and operational monitoring, as necessary, include increasing rock buttresses, dewatering LTV slimes, reducing stockpile height, and modifying benches to reduce slopes.[43]	All	4.13.3.5

[43] 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.

6.0 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible commitment of resources refers to the loss, as a result of the Project, of future options for resource development or management, especially of nonrenewable resources such as minerals and cultural resources. Irretrievable commitment of resources refers to the lost production or use value of renewable natural resources as a result of the Project.

The construction and operation of the Project (Proposed Action, Mine Site Alternative, and Tailings Basin Alternative) would result in the irreversible or irretrievable loss of minerals, wetlands, and tribal interests. Approximately 228 million tons of base and precious metal ore and lean ore would be removed over the life of the mine. Excavation of the mine pits and creation of waste rock stockpiles would also result in the irretrievable loss of 850 acres of wetland communities at the Mine Site as these resources would be permanently replaced by upland stockpiles and deep water in the West pit, neither of which would support wetland habitat. These impacts would be offset by the compensatory wetland mitigation plan for the Project; however, the majority of the wetland mitigation would not occur at the Mine Site.

The Mine Site also contains natural resources culturally important to tribes, including access to the land itself, which would be irreversibly lost following the proposed land exchange and conversion of the land from public to private ownership. This effect would be offset if the land exchange was of similar size and ecological value to the Mine Site and located within the 1854 Ceded Territory.

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