5.0 ENVIRONMENTAL CONSEQUENCES

5.1 INTRODUCTION

Pursuant to the requirements of NEPA regulations at 40 CFR 1502.16 and *Minnesota Rules*, part 4410.2300, this chapter describes the potential environmental consequences of the NorthMet Project Proposed Action and Land Exchange Proposed Action on the affected environment as described in Chapter 4.

As defined in 40 CFR 1508.8, the chapter addresses the following types of effects:

- direct effects, which are caused by the action and occur at the same time and place; and
- indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Evaluation criteria and analysis methodology are identified where applicable for each resource topic. Environmental effects were determined based on qualitative and/or quantitative assessment.

As listed in Table 5.1-1, this chapter follows the same structure and order of resource topics as Chapter 4. Section 5.2 describes the environmental consequences of the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative. Section 5.3 describes the environmental consequences of the Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative.

Table 5.1-1 Resource Topic Areas Discussed in Chapter 5

Resource Topic	NorthMet Project Proposed Action	Land Exchange Proposed Action
Land Use	5.2.1	5.3.1
Water Resources	5.2.2	5.3.2
Wetlands	5.2.3	5.3.3
Vegetation	5.2.4	5.3.4
Wildlife	5.2.5	5.3.5
Aquatic Species	5.2.6	5.3.6
Air Quality	5.2.7	5.3.7
Noise and Vibration	5.2.8	5.3.8
Cultural Resources	5.2.9	5.3.9
Socioeconomics	5.2.10	5.3.10
Recreation and Visual Resources	5.2.11	5.3.11
Wilderness and Special Designation Areas	5.2.12	5.3.12
Hazardous Materials	5.2.13	5.3.13
Geotechnical Stability	5.2.14	5.3.14

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5.2 NORTHMET PROJECT PROPOSED ACTION

5.2.1 Land Use

This section evaluates the NorthMet Project Proposed Action against existing and applicable land use plans. The specific focus is on the consistency of the NorthMet Project Proposed Action with accepted plans, zoning ordinances, or land use agency management plans. It also addresses the legacy contamination and how it would be affected by proposed activities.

Summary

Components of the NorthMet Project Proposed Action are variously subject to the requirements of local comprehensive land use plans or the Superior National Forest Plan. In all cases, the NorthMet Project Proposed Action activities are consistent with the formally adopted plans. The NorthMet Project Proposed Action would decrease the amount of land available for public access and use, and would decrease portions of the 1854 Ceded Territory available for use by the Bands. However, given the historic use of the federal lands within the Mine Site for mineral exploration and ongoing restrictions on public access (see Section 4.2.11), the NorthMet Project Proposed Action would result in little or no change in actual public use of these lands.

5.2.1.1 Methodology and Evaluation Criteria

The USFS uses the management area framework to broadly define the desired conditions and activities on lands within national forests. Land use outside the Superior National Forest is governed by local zoning and comprehensive plans. The management area designations applicable to the Mine Site and portions of the Transportation and Utility Corridor, as defined in the Forest Plan, are described in Section 4.2.1, as are zoning designations for land outside of the Superior National Forest.

The NorthMet Project Proposed Action is evaluated against the following Evaluation criteria:

- compatibility of proposed land use with existing land use, land use plans, zoning ordinances, 1854 Treaty obligations, and adjacent USFS management areas;
- anticipated outcomes related to identified contaminated lands; and
- the degree to which past, ongoing, or planned investigation and remediation actions at legacy contamination sites would be affected by disturbance associated with the NorthMet Project Proposed Action.

5.2.1.2 NorthMet Project Proposed Action

5.2.1.2.1 Consistency with Zoning and Comprehensive Plans

The NorthMet Project area lies within the Mineral Mining zoning districts of the cities of Babbitt and Hoyt Lakes (Arrowhead 2011; Hoyt Lakes Planning Commission 2010), and an industrial use district of St. Louis County (St. Louis County 2011). Therefore, the NorthMet Project area is compatible with the zoning ordinance and draft revised Comprehensive Land Use Plan and would not require an amendment of the respective zoning ordinances or Comprehensive Land Use Plans (Arrowhead 2011; City of Babbitt 1996). Both the county and municipal zoning districts surrounding the Plant Site are designated for industrial or mining use; the NorthMet

Project area is compatible with these designations and would not require amendments to current land uses. Privately owned parcels adjacent to the Mine Site fall under the same or similar zoning and land use designations; therefore, the NorthMet Project Proposed Action does not have the potential to conflict with surrounding land uses.

5.2.1.2.2 Consistency with Superior National Forest Plan

The Mine Site is located within the Superior National Forest and on lands designated as a General Forest-Longer Rotation Management Area (USFS 2011a). In such areas, the USFS allows exploration, development, and processing of mineral resources under conditions where activities are consistent with sound environmental management so as to contribute to economic growth. In addition to managing project development, the USFS also requires preparation of associated reclamation plans to ensure the long term protection and restoration of the natural resources (USFS 2004b). The NorthMet Project Proposed Action would be consistent with these policies.

The NorthMet Project Proposed Action would represent a reactivation of the use of road and rail line for mining, which would be compatible with existing corridor land uses. Under the NorthMet Project Proposed Action, Dunka Road would remain private for mine operation use. Superior National Forest lands to the east, south, and southwest of the Transportation and Utility Corridor are accessible by forest roads and are not dependent on Dunka Road for access (see Figure 4.3.1-1), although Forest Road 113 connects Dunka Road to County Road 110 near Skibo, Minnesota. The NorthMet Project Proposed Action represents no anticipated change in the level of public access to either of these adjacent Superior National Forest parcels.

5.2.1.2.3 Areas of Concern

Upon the purchase of a portion of the site, PolyMet became responsible for 29 AOCs (see legacy contamination discussion in Section 4.2.1.4). Of these, several have already been closed or have received a No Further Action letter from the MPCA (see Table 4.2.1-1). Additional investigation would be required to determine whether the remaining AOCs require further action. The NorthMet Project Proposed Action offers no direct resolution for the 33 AOCs that are designated as the responsibility of parties other than PolyMet (see Table 4.2.1-2). The MPCA VIC program would be utilized to facilitate and oversee remediation activity for any remaining potential historical releases on the 29 AOCs under the NorthMet Project Proposed Action.

5.2.1.3 NorthMet Project No Action Alternative

There would be no effects relative to baseline conditions as a result of the NorthMet Project No Action Alternative. The existing land use designations and 1854 Treaty obligations for the Mine Site and Plant Site would remain unchanged. The treatment of AOCs (including those for which PolyMet is now responsible, and other AOCs) would be the same as for the NorthMet Project Proposed Action.

5.2.2 Water Resources

This section is organized into a description of the criteria used for evaluating NorthMet Project Proposed Action-related effects, the methodologies used to predict project effects, and then a discussion of effects associated with the NorthMet Project Proposed Action, including both the mine and land exchange components and alternatives. A summary of the primary effects of the NorthMet Project Proposed Action on water resources is provided below.

Summary

The NorthMet Project Proposed Action would be located in an historic mining district, known as the Iron Range, and in the vicinity of other past, present, and proposed mining projects. Although the Mine Site would be on a greenfield site, PolyMet proposes to reuse many of the former LTVSMC facilities at the brownfield Plant Site. While reusing the LTVSMC Tailings Basin offers environmental benefits (e.g., reducing wetland effects, addressing legacy water quality issues), it does create some challenges as the existing LTVSMC Tailings Basin is not lined and currently releases seepage with elevated concentrations of sulfate, TDS, and hardness, among other constituents. Many of the engineering controls proposed by PolyMet at the Plant Site are related to managing seepage from both the existing LTVSMC Tailings Basin and the NorthMet Tailings Basin.

The NorthMet Project Proposed Action would have the potential to affect groundwater and surface water hydrology and quality in both the Partridge River and Embarrass River watersheds. These two rivers are both tributaries to the St. Louis River and within the Lake Superior Basin. They are not located within the Hudson Bay Basin and do not drain to, nor would affect the water quality of the BWCAW.

The NorthMet Project Proposed Action would represent the first copper-nickel-PGM mine in Minnesota, of which most of the ore and waste rock contains sulfide minerals (sulfide mine). Most of the waste rock and pit wall rock would contain sulfide sulfur (S). Sulfide minerals, when exposed to oxygen and water, have the potential to release soluble metals and sulfate and produce acid mine drainage. Mine-related blasting and excavation dramatically increases the oxidation rate of these minerals by increasing the surface area and porosity of the rock, which allows rapid introduction of atmospheric oxygen and flushing of solutes by water. The sulfide S concentrations of the NorthMet waste rock would be relatively low compared to many other sulfide mines around the world. The NorthMet waste rock is predicted to average 0.15 percent sulfide S, while concentrations in other sulfide mines range as high as 40 percent and average about 3.6 percent S (Minesite Drainage Assessment Group 2013). Hence, the anticipated average percent sulfide S, for the NorthMet mine is less than 1/20th the average concentration found in similar mines. The host silicate minerals in the deposit would help neutralize some acid generated by the sulfide minerals, such that the Category 1 Stockpile and the Tailings Basin are predicted to remain at neutral pH. Where the pore water pH remains near-neutral, metal mobility can be limited as some metals released by oxidation are removed from solution by adsorption or co-precipitation.

The sulfate released from the NorthMet waste rock and tailings is especially important because there are waters supporting the production of wild rice that are downstream from both the Mine Site and Tailings Basin and sulfate potentially stimulates the methylation of mercury, which is discussed below. Research suggests that elevated sulfate concentrations can affect the growth and viability of wild rice. The MPCA has established a 10 mg/L sulfate standard for stream segments designated as waters used for the production of wild rice. Existing sulfate concentrations in these “wild rice beds” along the Partridge and Embarrass rivers already exceed the 10 mg/L standard, so the NorthMet Project Proposed Action must demonstrate that it can meet this standard or at least show that it would not increase sulfate concentrations.

Since the issuance of the DEIS, PolyMet has significantly modified its proposed design by incorporating engineering controls at both the Mine Site and Tailings Basin to better address water resource issues. At the Mine Site, the more reactive waste rock (Category 2/3 and 4) is now proposed for subaqueous disposal in the East Pit. The less reactive Category 1 waste rock would be permanently stored at the surface, but would be surrounded by a containment structure that would collect and route nearly all seepage for treatment. A WWTF is proposed that would treat internal waste streams until year 40, and then would treat the West Pit lake overflow before discharge to a Partridge River tributary. At the Tailings Basin, PolyMet proposes a groundwater containment system that would capture nearly all of the seepage from the Tailings Basin and return it to the tailings pond for reuse at the processing plant or treatment. A WWTP is proposed that would provide mechanical treatment of the captured Tailings Basin seepage and the tailings pond water before discharging the treated effluent to augment flow in several tributary streams that would otherwise lose flow because of the groundwater containment system. At closure, PolyMet proposes a bentonite amendment of the top and side slopes of the Tailings Basin to reduce oxygen flux and water percolation into the tailings, thereby reducing the load of sulfate and metals seeping from the facility. The WWTF and the WWTP would continue operating until monitoring demonstrates that active treatment is no longer needed to meet water quality standards. The intent, however, is to transition from these mechanical treatment systems to non-mechanical systems (e.g., constructed wetlands, PRBs, permeable sorptive barriers) during closure. These non-mechanical systems would not be implemented until water quality at key project facilities (i.e., Category 1 Stockpile, West Pit, Tailings Basin, and Tailings Basin pond) are at a concentration range that can be effectively treated by these non-mechanical systems, based on a successful demonstration.

Several groundwater (MODFLOW), surface water (XP-SWMM), and water quality (GoldSim) models were linked to predict the hydrologic and water quality effects of the NorthMet Project Proposed Action. The GoldSim model, which was run at monthly time steps for 200 years for the Mine Site and 500 years for the Plant Site, performs probabilistic simulations, taking into consideration the uncertainty around many of the model input assumptions with the output taking the form of a cumulative probability distribution. The Co-lead Agencies have selected the 90^{th} percentile probability as its evaluation threshold in determining whether the model results meet established evaluation criteria (i.e., there is a 90 percent probability that the actual concentration would be either at or below the criteria during the entire model duration).

With the proposed design modifications and engineering controls, the GoldSim model predicts that the NorthMet Project Proposed Action would meet all groundwater and surface water quality evaluation criteria at the 90^{th}-percentile confidence level, or result in decreases in concentrations for a few solutes that exceed the criteria under existing conditions, for all of the 28 solutes modeled at all of the 26 evaluation locations over the 200-year (Mine Site) to 500-year (Plant Site) model duration. The engineering controls would maintain sulfate concentrations in the Partridge River wild rice beds and would significantly reduce sulfate loadings to the Embarrass River wild rice beds. Additionally, the NorthMet Project Proposed Action is not predicted to result in any significant effects on groundwater or surface water hydrology. Furthermore, the engineering controls provide a high degree of reliability that the evaluation criteria would continue to be met in the future.

Mercury is another constituent of concern, primarily because many of the lakes and rivers in the area are classified as “impaired waters” by the MPCA because of elevated mercury in fish. Elevated mercury in fish is the result of elevated availability of methylmercury, which could be caused by elevated inorganic mercury availability, and/or elevated efficiency of the methylation of mercury, which could be caused by a number of factors including enriched sulfate. The NorthMet Project area is located within the Lake Superior Basin, so it is subject to the Great Lakes Initiative mercury discharge standard of 1.3 ng/L. The NorthMet ore and waste rock contain trace amounts of mercury, but mass balance modeling and analog data from other natural lakes and mine pit lakes in northeastern Minnesota suggest that the mercury concentration in the West Pit Lake, the source of the only surface water discharge at the Mine Site, would stabilize at approximately 0.5 ng/L. There would also be mercury in the tailings, although about 92 percent of the mercury in the ore is predicted to remain in the ore concentrate and the mercury concentration in seepage from the Tailings Basin is expected to be less than the standard. Research by the MDNR has found that taconite tailings serve as a sink for mercury. Further, a small-scale bench study found that mercury also adsorbs to NorthMet tailings.

PolyMet has proposed monitoring to track effects on hydrology and water quality and refine modeling to help predict future outcomes. In the event that the monitoring or modeling identifies the potential for any exceedances, PolyMet has proposed an Adaptive Water Management Plan (AWMP) that identifies additional measures the firm could take if necessary to prevent any exceedances.

5.2.2.1 Evaluation Criteria

In general, water resource evaluation criteria focus on groundwater and surface water hydrology and water quality and are defined as thresholds or changes in the existing physical/chemical/biological environment with the goal of protecting overall waterbody health.

5.2.2.1.1 Groundwater

This section discusses evaluation criteria for the effects of the NorthMet Project Proposed Action on groundwater hydrology (primarily groundwater levels) and water quality.

Hydrogeologic Evaluation Criteria

There are currently no evaluation criteria for change in groundwater levels. It is recognized that groundwater drawdown would occur surrounding the mine pits and groundwater elevations may decrease near the Tailings Basin as a result of proposed engineering controls, but these changes are not necessarily good or bad in and of themselves. The significance of any changes in groundwater levels is evaluated in terms of its effects on other resources (e.g., wetlands) and are discussed in those appropriate resource sections. The magnitude of any changes in groundwater levels are quantified in this section.

Water Quality Evaluation Criteria

Groundwater quality is variable and is a reflection of the land and parent material. Based on host rock mineralogy and the results of geochemistry analyses, 28 solutes were selected as potentially being affected by the NorthMet Project Proposed Action and for inclusion in water quality modeling, including:

- Alkalinity
- Calcium
- Chloride
- Fluoride
- Hardness
- Sulfate
- Magnesium
- Potassium
- Sodium
- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Manganese
- Nickel
- Selenium
- Silver
- Thallium
- Vanadium
- Zinc

This suite of directly modeled solutes does not include TDS. However, TDS can be estimated by summing its constituent concentrations that were directly modeled, including calcium, chloride, fluoride, magnesium, potassium, sulfate, and a portion of alkalinity.

This SDEIS assesses effects by comparing predicted NorthMet Project Proposed Action-related water quality with both existing water quality (as characterized by groundwater quality monitoring) and applicable Minnesota groundwater quality standards, which are based on Minnesota water use classifications (*Minnesota Rules* 7060, 7050, and 7052). Groundwater quality standards are USEPA primary MCLs, USEPA sMCLs, and MDH HRLs. The groundwater quality evaluation criteria, for the purposes of this SDEIS, are defined as the strictest (i.e., lowest) concentration among the USEPA primary MCLs, USEPA sMCLs, and the MDH HRLs, with the following exceptions:

- Human health-based primary drinking water standards for copper and lead are “at the tap” values applicable to treated water systems and not to “in situ” groundwater values (see Note 3 to Table 5.2.2-2). *Minnesota Rules* addressing the water quality standards applicable to Class 1 waters used for domestic consumption specifically state that the primary drinking water standards for copper and lead do not apply to Class 1 surface waters or groundwater. The SDEIS uses the USEPA sMCL of 1,000 μg/L as the groundwater evaluation criteria for copper. Modeling predictions for lead are presented, but without a groundwater evaluation criterion for lead because there is not an sMCLs or an HRL for lead.
- Natural (unaffected) groundwater concentrations for aluminum and iron at the Mine Site and Plant Site are greater than secondary drinking water standards. The concentrations for these two solutes in groundwater are heavily influenced by processes not readily captured in GoldSim and other similar models (e.g., site-specific redox reactions). Furthermore, these

sMCLs were established by the USEPA as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, and can be removed from groundwater with simple readily available treatment technologies, and are not enforced by the USEPA. For example, concentrations above the aluminum sMCL (200 µg/L) may result in colored water and concentrations above the iron sMCL (300 µg/L) may result in rusty color, metallic taste, and reddish or orange staining.

- Natural (unaffected) groundwater concentrations for beryllium, manganese, and thallium (bedrock unit only) at the Mine Site and beryllium and manganese at the Plant Site are greater than secondary drinking water standards and/or the HRL (see Table 5.2.2-2). These elevated concentrations are consistent with concentrations seen elsewhere in the Iron Range and northeast Minnesota. *Minnesota Rules* (Part 7060.0600 subpart 8) states that "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."

The evaluation criteria for these three solutes, where background levels naturally exceeded the water quality standard, were developed in accordance with USEPA guidance using the 95 percent Upper Prediction Limits for all datasets (Table 5.2.2-1).

Table 5.2.2-1 Beryllium, Manganese, and Thallium Evaluation Criteria

	Units	USEPA Primary MCL	USEPA sMCL	HRL	# samples	Range	Mean	Recommended Evaluation Criteria
Mine Site		**Surficial**						
Beryllium	µg/L	4	--	0.08	176	ND–1.6	0.23	0.45[(1)]
Manganese	µg/L	--	50	100	167	ND–1900	294	964[(1)]
Mine Site		**Bedrock**						
Beryllium	µg/L	4	--	0.08	35	ND–0.2	<0.2	0.2[(2)]
Manganese	µg/L	--	50	100	35	ND–383	98	279[(1)]
Thallium	µg/L	2	--	0.6	35	ND (0.2–2.0)	<2	1.0[(2)]
Plant Site		**Surficial**						
Beryllium	µg/L	4	--	0.08	28	ND–2.72	0.31	0.49[(2)]
Manganese	µg/L	--	50	100	28	4.3–2,140	291	1,506[(1)]

Source: Barr 2013h.

ND = Non-detect
1 95 percent Upper Prediction Limits used to set evaluation criteria.
2 Kaplan-Meier Method used to set evaluation criteria.

Table 5.2.2-2 presents the primary MCL, sMCL, HRL, and the evaluation criteria used in this EIS.

Table 5.2.2-2 Groundwater Evaluation Criteria Applicable to the NorthMet Project

Solute[1]	Units	USEPA Primary MCL	MDH HRL	USEPA sMCL	SDEIS Evaluation Criteria
General Parameters					
Alkalinity	mg/L	--	--	--	--
Calcium	mg/L	--	--		
Chloride	mg/L	--	--	250	250
Fluoride	mg/L	4	--	2	2
Hardness	mg/L	--	--	--	--
Magnesium	mg/L	--	--	--	--
Potassium	mg/L	--	--	--	--
Sodium	mg/L	--	--	--	--
Sulfate	mg/L	--	--	250	250
Total Dissolved Solids	mg/L	--	--	500	500
Metals					
Aluminum	µg/L	--	--	50-200[4]	--[4]
Antimony	µg/L	6	6	--	6
Arsenic	µg/L	10	--	--	10
Barium	µg/L	2,000	2,000	--	2,000
Beryllium	µg/L	4	0.08	--	0.45/0.2/0.49[6]
Boron	µg/L	--	1,000[2]	--	1,000
Cadmium	µg/L	5	4	--	4
Chromium	µg/L	100	--	--	100
Cobalt	µg/L	--	--	--	--
Copper[3]	µg/L	--[3]	--	1,000	1,000
Iron	µg/L	--	--	300	--[4]
Lead[3]	µg/L	--[3]	--	--	--
Manganese	µg/L	--	100	50	964/279/1506[6]
Nickel (soluble salts)[5]	µg/L	--	100	--	100
Selenium	µg/L	50	30	--	30
Silver	µg/L	--	30	100	30
Thallium (salts)[5]	µg/L	2	0.6	--	0.6/1.0[6]
Vanadium	µg/L	--	50	--	50
Zinc	µg/L	--	2,000	5,000	2,000

Source: Primary MCL (40 CFR 141); sMCL (40 CFR 143) and HRLs (*Minnesota Rules*, part 4717.7500).

1 Unless noted otherwise, the criteria apply to total concentrations.
2 Boron. See MDH guidance: www.health.state.mn.us/divs/eh/risk/guidance/gw/boron.html.
3 Lead and copper. Lead and copper enter drinking water primarily through plumbing materials. In 1991, the USEPA 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 percent of customer taps, require the water system to take additional actions to control corrosion. Therefore, these values reflect concentrations at the customer tap. Additionally, *Minnesota Rules*, part 7050.0221, subpart 1B, states that the primary drinking water standards for copper and lead are not applicable to Class 1 groundwaters.
4 Aluminum and iron. These parameters were excluded from groundwater evaluation criteria due to baseline USEPA sMCL standard exceedances in the Iron Range and Northeast Minnesota and because these concentrations are heavily influenced by processes not captured in the proposed models (e.g., site-specific redox reactions). Further, standards for these parameters were

established for management of aesthetic conditions in treated drinking water and are readily removed from groundwater with simple readily available treatment technologies. This policy was adopted by the Co-lead Agencies in the NorthMet EIS Groundwater Impact Assessment Planning Final Summary Memo (June 27, 2011).

[5] Nickel and thallium. The MDH HRL is based on the salt form of this parameter. It is conservatively assumed, for purposes of the SDEIS, that the salt form is equivalent to the total concentrations of this parameter.

[6] Beryllium, manganese, and thallium (Mine Site bedrock unit only). The evaluation criteria differ by location based on background water quality (see Table 5.2.2-1 above).

These groundwater quality evaluation criteria are assessed at the following evaluation locations (see Figures 5.2.2-4 and 5.2.2-6):

- Partridge River Watershed
  - Surficial Aquifer
    - East Pit and Category 2/3 Flowpath – at the Partridge River
    - Ore Surge Pile Flowpath – at the Partridge River
    - WWTP Flowpath – at the property boundary
    - Overburden Storage and Laydown Area Flowpath – at the property boundary
    - West Pit Flowpath – at the property boundary
  - Bedrock
    - East Pit Bedrock Flowpath – at property boundary
    - West Pit Bedrock Flowpath toward SW-004 – at property boundary
    - West Pit Bedrock Flowpath toward SW-004a – at property boundary
- Embarrass River Watershed (all surficial aquifer, see Section 5.2.2.2.3)
  - North Flowpath – at the north property boundary
  - Northwest Flowpath – at the northwest property boundary
  - West Flowpath – at the west property boundary

5.2.2.1.2 Surface Waters

This section discusses evaluation criteria for the effects of the NorthMet Project Proposed Action on surface water hydrology and quality.

<u>Hydrologic Alteration of Streams and Lakes Evaluation Criteria</u>

Hydrologic evaluation criteria include a comparison of proposed hydrologic changes with both existing natural conditions and historic hydrologic alterations from permitted mining practices, an assessment of present and predicted channel stability, and review of any appropriate physical or biological stream data. Evaluation criteria for stream flows in the Partridge River Watershed and changes in lake or reservoir levels in the NorthMet Project area are those developed by (Richter et al.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 (i.e., 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 (i.e., 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 (i.e., the number of days per year with mean flows above the 75th percentile of all simulated daily mean flows);
- duration of low pulses (i.e., the number of days per year with mean flows below the 25th percentile of all simulated daily mean flows);
- mean duration of high pulses (i.e., the ratio of duration of high pulses to number of high pulses);
- mean duration of low pulses (i.e., 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 magnitude of deviation from existing conditions, based on XP-SWMM modeling, in the mean values of the hydrologic parameters help determine the degree of potential effect on stream ecology. These values are not expressed as compliance standards, but will assist in monitoring effects and recommending potential mitigation measures as appropriate.

Water Quality Evaluation Criteria

This SDEIS assesses effects by comparing predicted NorthMet Project Proposed Action-related water quality with both modeled no action water quality (as characterized by surface water quality monitoring) and evaluation criteria based on State of Minnesota water use classifications (*Minnesota Rules* 7050 and 7052) and associated standards. Applicable use classifications of the primary surface waters potentially affected by the NorthMet Project Proposed Action are described in Section 4.2.2 and are summarized in Table 5.2.2-3.

Table 5.2.2-3 Applicable Use Classifications of the Primary Surface Waters in the NorthMet Project Area

Watershed	Stream Name	Domestic Consumption	Aquatic Life and Recreation			Industrial Consumption		Agriculture and Wildlife		Aesthetic Enjoyment	Other uses
		1B	2A	2B	2Bd	3B	3C	4A	4B	5	6
Partridge	Partridge River			X			X	X	X	X	X
Partridge	Longnose Creek			X			X	X	X	X	X
Partridge	Wetlegs Creek			X			X	X	X	X	X
Partridge	Wyman Creek	X	X			X	X	X	X	X	X
Partridge	Colby Lake	X			X		X	X	X	X	X
Embarrass	Embarrass River			X			X	X	X	X	X
Embarrass	Trimble Creek			X			X	X	X	X	X
Embarrass	Mud Lake Creek[1]			X			X	X	X	X	X
Embarrass	Second Creek			X			X	X	X	X	X
Embarrass	Unnamed Creek			X			X	X	X	X	X

[1] Mud Lake Creek is an unofficial name given the Unnamed Creek that flows north from the northeast corner of the Tailings Basin. It was given this name because of Mud Lake near the headwaters of the stream, and to distinguish it from the other Unnamed Creek that flows northwest from the northwest corner of the tailing basin. It is referred to as Mud Lake Creek throughout the SDEIS.

In *Minnesota Rules* part 7050.0221, the USEPA primary and secondary drinking water standards are adopted for Class 1B waters (i.e., treated with simple chlorination for domestic consumption). The USEPA primary drinking water standards (40 CFR 141) set mandatory MCLs for drinking water contaminants to protect the public from consumption of water that presents a risk to human health. The USEPA has also established secondary drinking water standards (40 CFR 143) for 15 contaminants that 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 a risk to human health.

The same suite of solutes was modeled for surface waters as described above for groundwater. As mentioned above, TDS concentrations were not directly modeled, but can be estimated indirectly by summing its constituents that were directly modeled.

Because the NorthMet Project area is located 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 chapter 7052, the standards from chapter 7050 apply.

Surface water standards are "in-stream" standards applicable at the surface water in question, which includes the Partridge River and its tributaries for the Mine Site, Transportation and Utility Corridor, and the processing plant area; and the Embarrass River and its tributaries for the majority of the Tailings Basin.

Applicable surface water quality evaluation criteria, for the purposes of this SDEIS, are listed by use classification in Table 5.2.2-4, with the strictest (i.e., lowest) concentration from the applicable water use classifications applying.

It should be noted that the water quality standards for metals are expressed as total metal in the table, but are applied as dissolved metal criteria for application to surface waters (*Minnesota Rules*, part 7050.0220). For the majority of metals, the ratio of the total metal criteria to the dissolved metal criteria is sufficiently close to one such that the total standard is adequately representative of the applicable criteria.

Table 5.2.2-4 Surface Water Quality Evaluation Criteria Applicable to the NorthMet Project Proposed Action

Parameter	Units	Class 1B Primary MCL	Class 1B sMCL	Class 2Bd[3]	Class 2B[3]	Class 3B[4]	Class 3C[4]	Class 4A[5]	Class 4B[5]	Class 5	Class 6
General											
Alkalinity	mg/L	--	--	--	--	--	--	--	--	--	--
Calcium	mg/L	--	--	--	--	--	--	--	--	--	--
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	--	--	--	--
Magnesium	mg/L	--	--	--	--	--	--	--	--	--	--
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	--
Potassium	mg/L	--	--	--	--	--	--	--	--	--	--
Specific Conductance	mg/L	--	--	--	--	--	--	1,000	--	--	--
Sodium	mg/L	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/L	--	250	--	--	--	--	10[2]	--	--	--
TDS	mg/L	--	500	--	--	--	--	700	--	--	--
Metals Total[7]						--	--	--	--	--	--
Aluminum	µg/L	--	50-200	125	125	--	--	--	--	--	--
Antimony	µg/L	6	--	5.5	31	--	--	--	--	--	--
Arsenic	µg/L	10	--	2.0[1]	53[1]	--	--	--	--	--	--
Barium	µg/L	2,000	--	--	--	--	--	--	--	--	--
Beryllium	µg/L	4.0	--	--	--	--	--	--	--	--	--
Boron	µg/L	--	--	--	--	--	--	500	--	--	--
Cadmium[6]	µg/L	5	--	2.5[1]	2.5[1]	--	--	--	--	--	--
Cobalt	µg/L	--	--	2.8	5.0	--	--	--	--	--	--
Copper[6]	µg/L	--[8]	1,000	9.3[1]	9.3[1]	--	--	--	--	--	--
Iron	µg/L	--	300	--	--	--	--	--	--	--	--
Lead[6]	µg/L	--[8]	--	3.2	3.2	--	--	--	--	--	--
Manganese	µg/L	--	50	--	--	--	--	--	--	--	--
Mercury	ng/L	2,000	--	1.3	1.3[1]	--	--	--	--	--	--
Nickel[6]	µg/L	--	--	52[1]	52[1]	--	--	--	--	--	--
Selenium	µg/L	50	--	5.0[1]	5.0[1]	--	--	--	--	--	--
Silver[6]	µg/L	--	100	1.0	1.0	--	--	--	--	--	--

Parameter	Units	Class 1B Primary MCL	Class 1B sMCL	Class 2Bd[3]	Class 2B[3]	Class 3B[4]	Class 3C[4]	Class 4A[5]	Class 4B[5]	Class 5	Class 6
Thallium	µg/L	2	--	0.28	0.56	--	--	--	--	--	--
Vanadium	µg/L	--	--	--	--	--	--	--	--	--	--
Zinc[6]	µg/L	--	5,000	120[1]	120[1]	--	--	--	--	--	--

Source: *Minnesota Rules*, chapters 7050 and 7052; USEPA Primary MCL (40 CFR 141); sMCL (40 CFR 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 *Minnesota Rules*, part 7050.0140.

[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*, parts 7050.0222 and 7052.0100.

[4] *Minnesota Rules*, part 7050.0223.

[5] *Minnesota Rules*, part 7050.0224.

[6] Water quality standard for this metal is hardness dependent. The listed value assumes a hardness of 100 mg/L.

[7] 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*, parts 7050.0222 and 7052.0360.

[8] Lead and copper enter drinking water primarily through plumbing materials. In 1991, USEPA 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 percent of customer taps, require the water system to take additional actions to control corrosion. Therefore, these values reflect concentrations at the customer tap. Additionally, *Minnesota Rules*, part 7050.0221, subpart 1B, states that the primary drinking water standards for copper and lead are not applicable to Class 1 surface waters.

Surface Water Quality Evaluation Locations

These surface water quality standards are assessed at the following surface water evaluation locations (see Figures 4.2.2-8 and 4.2.2-15):

- Partridge River Watershed
  - Partridge River – at SW-002, SW-003, SW-004, SW-004a, SW-004b, SW-005, and SW-006; and
  - Colby Lake.
- Embarrass River Watershed
  - Embarrass River – at PM-12, PM-12.2, PM-12.3, PM-12.4, PM-13;
  - Mud Lake Creek – at MLC-2 and MLC-3;
  - Trimble Creek – at TC-1 and PM-19; and
  - Unnamed Creek – at PM-11.

Relationship of Hardness to Evaluation Locations

There are five metals whose chronic water quality standards are based on hardness concentrations: cadmium, copper, lead, nickel, and zinc. The water quality standards for these metals vary with the hardness concentration. Calcium and magnesium ions that contribute to water hardness generally lower metals toxicity (i.e., as hardness concentration increases, the water quality standard for these metals also increases).

Within the GoldSim probabilistic modeling, estimated concentrations for these five metals are compared to hardness-based standards at each model evaluation location and each model time step to determine compliance with the evaluation criteria. Hardness-based standards are calculated differently at different evaluation locations for the reasons described below:

- Headwater discharge locations – which include model evaluation locations that periodically have little or no flow, and where discharges from project sources may represent a significant portion of the total flow. At these locations in the Partridge River Watershed, the instantaneous modeled hardness of the discharge at each time step is used to calculate the hardness-based metal standard. In the Embarrass River Watershed locations, modeled hardness was used.
- Non-headwater discharge locations – which include model evaluation locations that receive perennial flow and where discharges from project sources represent a variable percentage of the total stream flow. At these locations, the median hardness measured (not modeled) in the receiving stream is used to calculate the hardness-based metal standard.
- Non-discharge locations – which include model evaluation locations that are downstream of locations that receive project discharges. At these locations, the instantaneous modeled hardness in the receiving stream is used to calculate the hardness-based metal standard.

Downstream Water Quality Standards

Discharges are also analyzed in the SDEIS relative to downstream waterbodies and their associated evaluation criteria because they may have more stringent water quality standards. For example, the Fond du Lac Band has promulgated water quality standards that are protective of specific, designated, or beneficial uses for waterbodies on the Fond du Lac Reservation, which is located approximately 70 miles downstream of the NorthMet Project area on the St. Louis River. These standards were approved by the USEPA in December 2001. They apply to all waters, including wetlands, within the Reservation. The Fond du Lac water quality standards include determination of designated or beneficial uses, narrative and numeric criteria to support or sustain those uses, and anti-degradation provisions.

Based upon results of Fond du Lac Band water quality monitoring, as well as additional resource investigations, the Reservation's reach of the St. Louis River is attaining all of its beneficial uses and meeting all applicable water quality standards with the exception of mercury. In-stream mercury concentrations in the St. Louis River, measured by the Fond du Lac Band, have been below the Great Lakes Initiative Chronic Wildlife Standard of 1.3 ng/L, but exceed the Fond du Lac Band's human health chronic standard of 0.77 ng/L. For this reason, the Fond du Lac Band is especially concerned about any new or expanded discharges to the St. Louis River upstream of the Reservation that may adversely affect mercury bioaccumulation in fish in the St. Louis River (Schuldt 2012).

Mercury Evaluation Criteria

Mercury numeric standards are based on total (particulate plus dissolved) concentrations. For the Lake Superior Basin, in which the NorthMet Project area is located, the Class 2B (aquatic life and recreation) numeric chronic standard for mercury in the water column protective of wildlife is 1.3 ng/L, which is the most stringent applicable standard (with the exception of the downstream standard at the Fond du Lac Reservation).

There is a relationship, only partially known, between sulfate concentration and the conversion of inorganic mercury by sulfate reducing bacteria into methylmercury. Methylmercury is much more of a problem than inorganic mercury, in that it can accumulate to concentrations of concern in the aquatic food chain, it is more bioavailable than inorganic mercury, and it can bioaccumulate in fish, wildlife, and humans. Currently, there is no State of Minnesota surface water quality standard for methylmercury, or for sulfate in the context of its potential for effect on methylmercury concentrations. However, the State of Minnesota has a fish tissue water quality standard for mercury of 0.2 mg/kg, which was amended in *Minnesota Rules*, chapter 7050, in 2008. In 2006, the MPCA also 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.

The Minnesota Rules fish tissue standard for mercury of 0.2 mg/kg 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. Based on the results of scientific investigations, this criterion assumes that all fish tissue mercury is in the methylmercury form..

Mercury in fish tissue is relevant to water resources evaluation criteria considerations, but modeling did not attempt a numeric analysis of NorthMet Project Proposed Action-specific effects on mercury in fish tissue. The ability of numeric models to predict concentrations of mercury in fish tissue in response to changes in mercury-loading is currently inadequate due to gaps in scientific knowledge. The relationship of inorganic mercury-loading to uptake of methylmercury in fish is inherently complex and subject to numerous chemical, physical, and biological parameters, which vary geographically and are only partially understood. This is further discussed in Section 5.2.6 of this SDEIS.

Waters Used for the Production of Wild Rice Evaluation Criteria

Minnesota Rules, part 7050.0224, defines the Class 4A water quality standards for the Agriculture and Wildlife Use Classification, which includes a 10 mg/L sulfate standard "applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels." Application of this standard is therefore dependent on the identification of specific waters used for the production of wild rice and a determination of the period when rice may be susceptible to damage by sulfate.

When evaluating any facility or project with potential effects on wild rice production, the MPCA considers all available information to determine on a case-by-case basis which surface waters are used for the production of wild rice (MPCA 2006). For the NorthMet Project Proposed Action, the MPCA considered available non-regulatory (i.e., not promulgated by rule) lists of wild rice beds assembled by the MDNR, the 1854 Treaty Authority and the Wild Rice Management Workgroup (a coalition of federal, state, and tribal resource managers and other wild rice stakeholders), and the results of site-specific wild rice field surveys conducted in 2009, 2010, and 2011 in the Partridge River and Embarrass River.

To date within the NorthMet Project area, MPCA (2012a) has reached a draft staff recommendation that the following are "waters used for the production of wild rice (Figure 5.2.2-1):

Within the Embarrass River Watershed

- that segment of the Embarrass River from MN Highway 135 bridge to the inlet to Sabin Lake,
- the northernmost tip of Wynne Lake (Embarrass River inlet), and
- Embarrass Lake.

- Within the Partridge River Watershed
  - that portion of Upper Partridge River from river mile approximately 22 just upstream of the railroad bridge near Allen Junction to the inlet to Colby Lake,
  - that portion of Lower Partridge River from the outlet of Colby Lake to its confluence with the St. Louis River, and
  - that portion of Second Creek from First Creek to the confluence with Partridge River.

Further designations of wild rice beds by the MPCA are possible.

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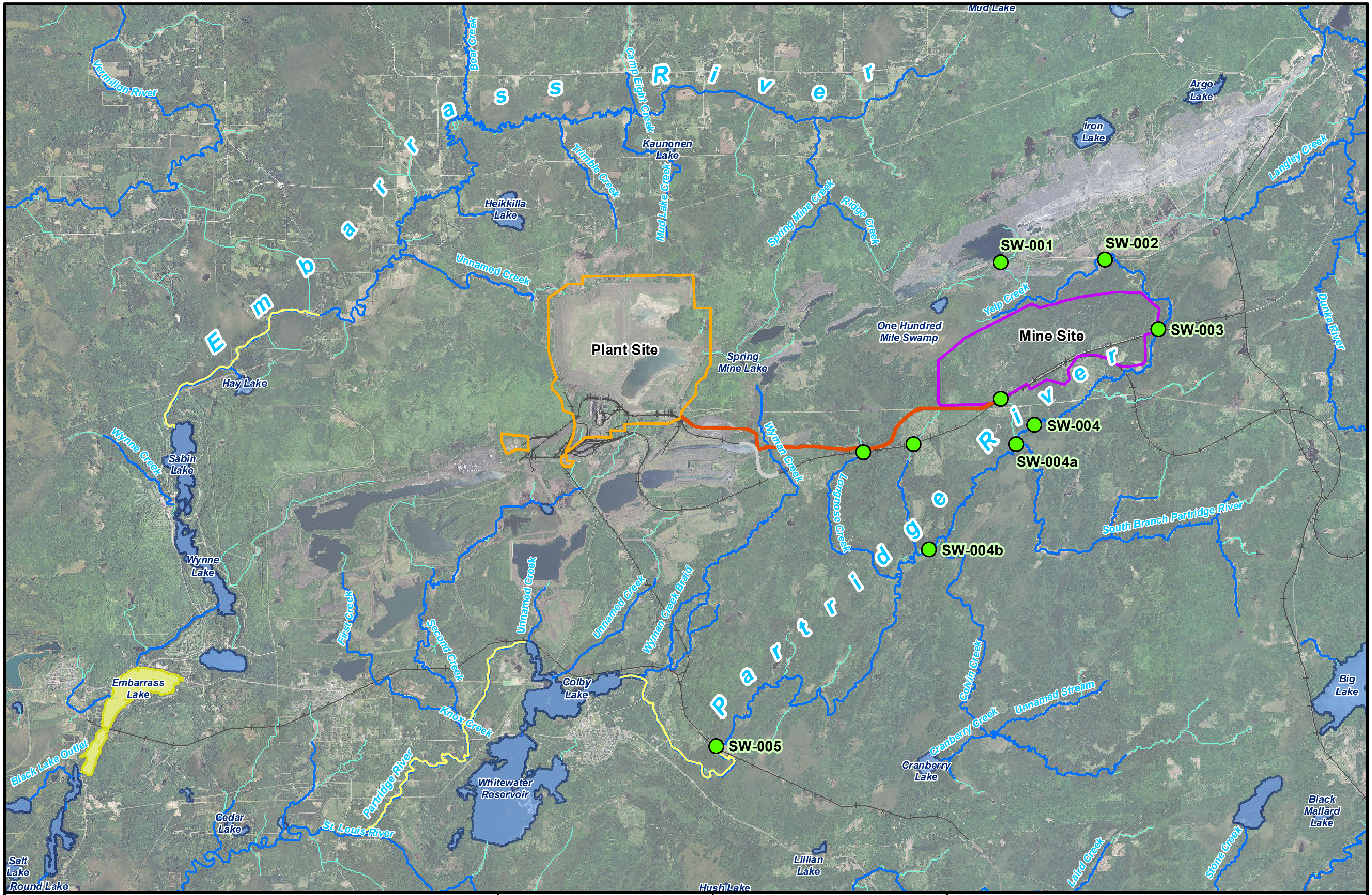

MPCA Staff-Recommended Wild Rice Water
MPCA Staff-Recommended Wild Rice Water
MDNR Designated PWI Stream/River
Non MDNR Designated PWI Stream/River
MDNR Designated PWI Lake/Wetland
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Existing Railroad

US Army Corps of Engineers
St. Paul District

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0 0.5 1 2 3 Miles

Figure 5.2.2-1
MPCA Staff-Recommended Wild Rice Waters
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The MPCA also reached a draft staff recommendation (MPCA 2012b; MPCA 2012c), based on research findings and currently available information applicable to the Partridge River and Embarrass River systems, that the period when wild rice may be susceptible to damage by high sulfate levels (and thus, when the 10 mg/L sulfate water quality standard would be applicable) be defined as April 1 to August 31. This recommendation was primarily based on nutrient uptake during critical growth stages of wild rice plant growing in Minnesota, as well as MPCA permitting/environmental review precedents. MPCA staff will consider additional information that may become available in the future, whether from NorthMet Project Proposed Action proponents or from other interested or affected parties, and reserves the right to modify their recommendation accordingly. PolyMet is not seeking application of the seasonal component of this standard for the NorthMet Project Proposed Action.

Therefore, for the purposes of this SDEIS, the wild rice sulfate evaluation criterion can be summarized as 10 mg/L standard applicable to the "upper" Partridge River and Embarrass River at PM-13.

5.2.2.1.3 Application of Evaluation Criteria to Probabilistic Modeling Results

PolyMet used a probabilistic model (GoldSim) to estimate potential effects by the NorthMet Project Proposed Action on groundwater and surface water quality. The output of the GoldSim model is not a single value for a particular solute concentration at a specific evaluation location and time, but rather is expressed as a cumulative frequency distribution of predicted concentrations, which can be used to assess the probability that the NorthMet Project Proposed Action would exceed any water quality evaluation criteria.

The predicted 90th-percentile (referred to herein as the P90 value) model concentration of a solute is used as the threshold for determining if the evaluation criteria at evaluation locations are exceeded during the entire model duration. In other words, if the modeled P90 value was exactly equal to the evaluation criterion, there is a 90 percent probability that the actual concentration would be below the criterion, and a 10 percent chance that the actual concentration would exceed the criterion. This P90 threshold has been adopted for other mining NEPA documents where probabilistic modeling was used (e.g., Idaho Cobalt Project [USFS 2009b]). The overall analysis of NorthMet Project Proposed Action effects on water quality also takes into consideration the extent to which predicted water quality compares with existing or No Action Alternative conditions. The Co-lead Agencies also retain the flexibility to modify this evaluation criteria based on consideration of low-flow modeling analyses, site-specific factors, and model predictions, with consideration of applicable permitting regulations and guidance.

5.2.2.2 Methodology

There have been substantial changes to the methodology used for predicting NorthMet Project Proposed Action effects on groundwater and surface flow and quality since the DEIS. For example, the DEIS evaluated water quality at the Mine Site using three deterministic cases (i.e., low, medium, and high flow conditions), in an attempt to capture uncertainty associated with some of the input values. This was supplemented by limited uncertainty analysis to help assess whether the deterministic modeling produced conservative values. The uncertainty analysis in the DEIS indicated mixed results regarding the conservatism of the deterministic modeling.

Table 5.2.2-5 Definition of Terminology

Term	Definition
Uncertainty	Absolute true value (or process) is unknown.
Variability	There is no single correct absolute value, values vary with time and/or space.
Deterministic Simulation	All input parameters represented as single values, no uncertainty (e.g., potential range of values).
Probabilistic Simulation	Uncertain or variable parameters represented by probability distributions.

For the SDEIS, a probabilistic modeling approach was used for predicting project effects on water resources. The probabilistic approach not only enables prediction of effects on groundwater and surface water from the NorthMet Project Proposed Action, but it also helps quantify the probability of the effects occurring and characterize the uncertainty around the predictions. Table 5.2.2-6 compares the modeling approach used in the DEIS with the approach used in the SDEIS:

Table 5.2.2-6 Comparison of DEIS and SDEIS Modeling Approaches

Previous DEIS	Current SDEIS
Stand-alone model components	Linked source-to-evaluation location
Discrete points in time with interpolation	Continuous through time until or near steady-state conditions reached
Deterministic with three cases	Probabilistic, including uncertainty and variability
Separate uncertainty analysis of select components	Fully integrated uncertainty analysis of entire model

The effects of the NorthMet Project Proposed Action on groundwater and surface water quality within the Partridge River Watershed were evaluated using a methodology that linked groundwater hydrologic modeling using MODFLOW, surface water hydrologic modeling using XP-SWMM, and water quality modeling using GoldSim. Detailed descriptions of how these models were applied to the Mine Site are provided in the Mine Site Water Modeling Data Package (PolyMet 2013i) and Mine Site Water Modeling Work Plan (Barr 2012d). At the Plant Site, the modeling consisted of MODFLOW, GoldSim, and a spreadsheet compilation of streamflows for different watersheds based on Embarrass River stream gauging data. Detailed descriptions of how these models were applied to the Plant Site are provided in the Plant Site Water Modeling Data Package (PolyMet 2013j) and Plant Site Water Modeling Work Plan version 7 (Barr 2012e). Each of the three model types is summarized below.

5.2.2.2.1 Groundwater Hydrologic Modeling (MODFLOW)

MODFLOW is a public-domain, numerical, finite-difference groundwater flow model that can simulate three-dimensional saturated flow in heterogeneous media (McDonald and Harbaugh 1988). Input to the model includes delineation of the areal and vertical extent of geologic materials, hydrologic characteristics of those materials (e.g., hydraulic conductivity), meteoric recharge, and alignment of hydrologic boundaries (e.g., perennial stream channels). MODFLOW provided estimates of hydraulic head distributions, groundwater flows/directions in the surficial aquifer and bedrock units, and baseflow discharges to perennial streams. By adjusting hydraulic conductivity and recharge inputs, the MODFLOW models were calibrated to measured hydraulic heads in monitoring wells and measured baseflows in the Partridge River and Embarrass River.

Mine Site

The Mine Site MODFLOW model was used to simulate groundwater flow in both the surficial groundwater system and the bedrock unit. The aerial extent of the groundwater model and simulated hydrologic features are shown on Figure 5.2.2-2 and Figure 5.2.2-3. MODFLOW was used to estimate:

- hydraulic conductivities of surficial materials (glacial drift, wetland deposits),
- hydraulic conductivities of bedrock types,
- aerial recharge, and
- groundwater inflows/outflows at mine pits.

The model was programmed with two layers; one for the surficial groundwater system and one for bedrock. Model calibration was performed by varying input hydraulic conductivities and recharge so that the model-simulated hydraulic heads were a reasonable match to water levels measured in monitoring wells and model-simulated discharges to the Partridge River were consistent with estimated baseflows at stations SW002, SW003, and SW004 taken from the XP-SWMM model. A description of the MODFLOW model and calibration process is provided in the Mine Site Water Modeling Data Package (PolyMet 2013i, Attachment C).

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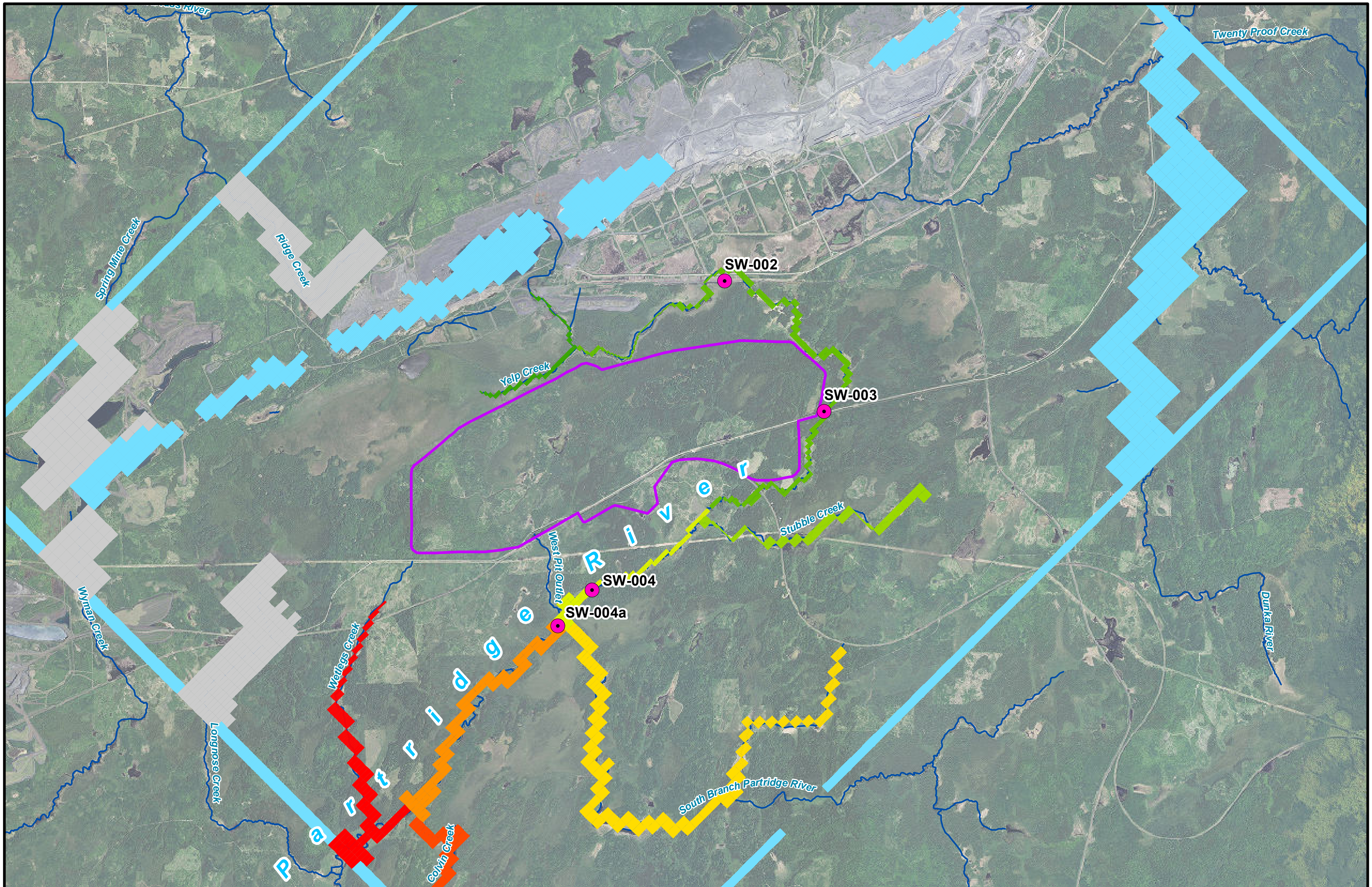

Surface Water Modeling/Monitoring Location
River Cells Not Adjusted During Calibration
River Cells Adusted During Calibration
1
2
3
4
5
6
7
8
Mine Site
Specified Head Cells
Stream/River

US Army Corps of Engineers
St. Paul District

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N W E S

0 0.25 0.5 1 1.5 Miles

Figure 5.2.2-2
Mine Site MODFLOW Model - River Reaches
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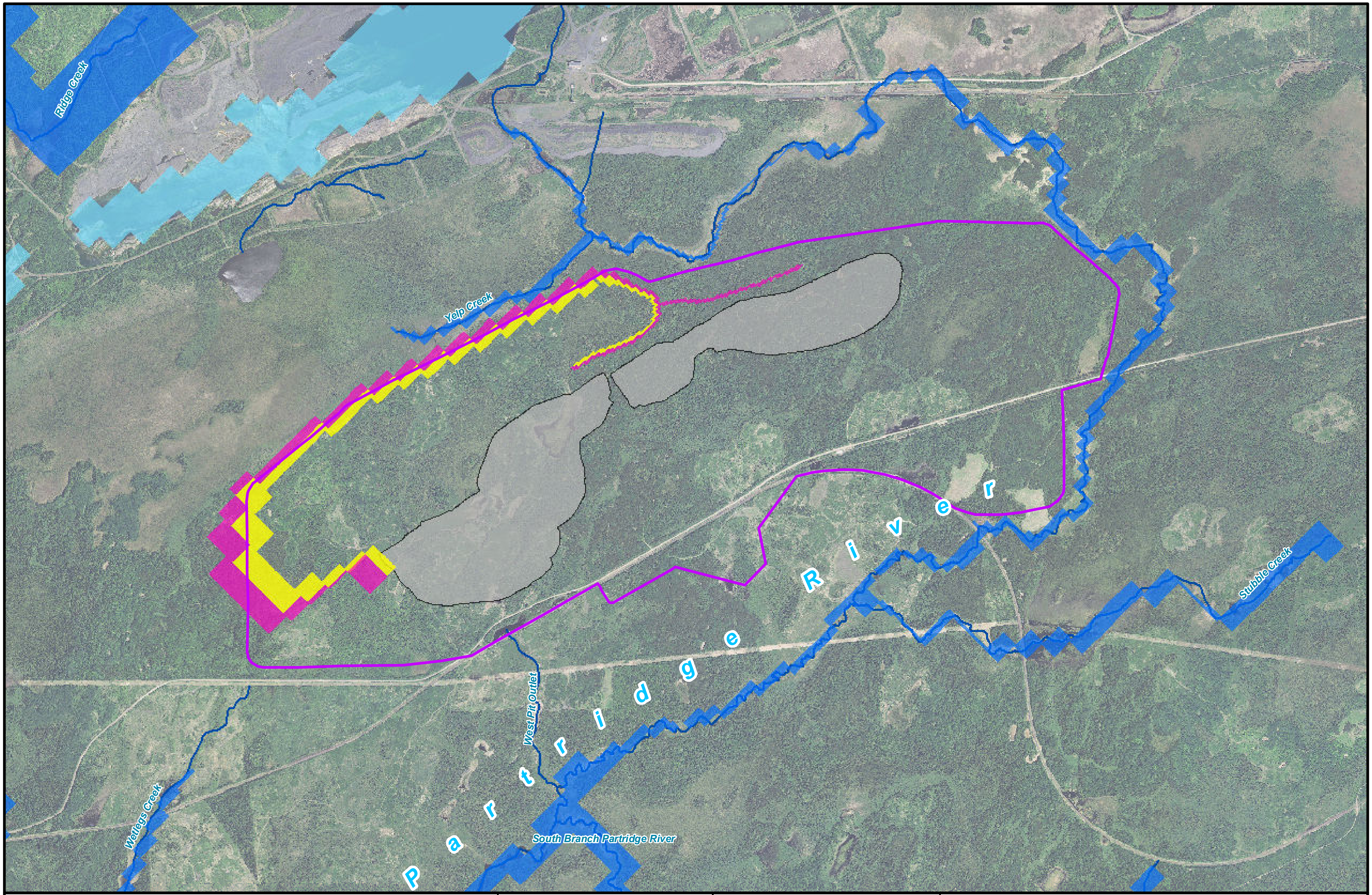

Specified Head Cell
River Cell
Low-K Cell Representing Soil Barrier or Cutoff Wall
Drain Cell Representing Category 1 Drainage Collection System
Mine Site
Mine Pit
Stream/River

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N W E S

0 1,000 2,000 4,000 Feet

Figure 5.2.2-3

Mine Site MODFLOW Model - Groundwater Containment System Features

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The MODFLOW-calibrated hydraulic conductivities for different geologic units are summarized in Table 5.2.2-7. The calibrated meteoric recharge flux is 1.8 in/yr for glacial drift and 0.36 in/yr for wetland deposits.

Table 5.2.2-7 Mine Site Hydraulic Conductivities Based on MODFLOW Calibration

Major Unit	Subunit	Horizontal Hydraulic Conductivity			Vertical Hydraulic Conductivity
		Minimum	Mean	Maximum	
		ft/day	ft/day	ft/day	ft/day
Surficial Materials	Glacial drift	0.095	17.4	164	0.0028
	Wetland deposits	0.017	5.6	143	0.0028
Bedrock	Giants Range Batholith	(a)	0.026	(a)	0.0026
	Biwabik Iron Fm.	(a)	1.2	(a)	0.12
	Upper Virginia Fm.	(a)	0.072	(a)	0.0072
	Duluth Complex	(a)	0.00049	(a)	0.000049
	Lower Virginia Fm.	(a)	0.019	(a)	0.0019

(a) Single-value calibration values were developed for bedrock units; min/max values were not evaluated

Figure 5.2.2-4 shows surficial groundwater flowpaths with the potential to transport mine-affected groundwater from identified source areas to designated evaluation locations as incorporated into the GoldSim model. The hydrologic characteristics of each surficial flowpath are summarized in Table 5.2.2-8. Due to the generally low hydraulic conductivity of bedrock, independent calculations and GoldSim results indicate that groundwater transport in bedrock is minimal and does not affect chemical concentrations at the evaluation locations.

Bedrock flowpaths and evaluation locations are also programmed into GoldSim, but because the bedrock (primarily the Duluth Complex) is highly competent with extremely low hydraulic conductivities (see Table 5.2.2-7), very little groundwater transport occurs within the bedrock flowpaths and travel times to evaluation locations are predicted to be in the thousands of years.

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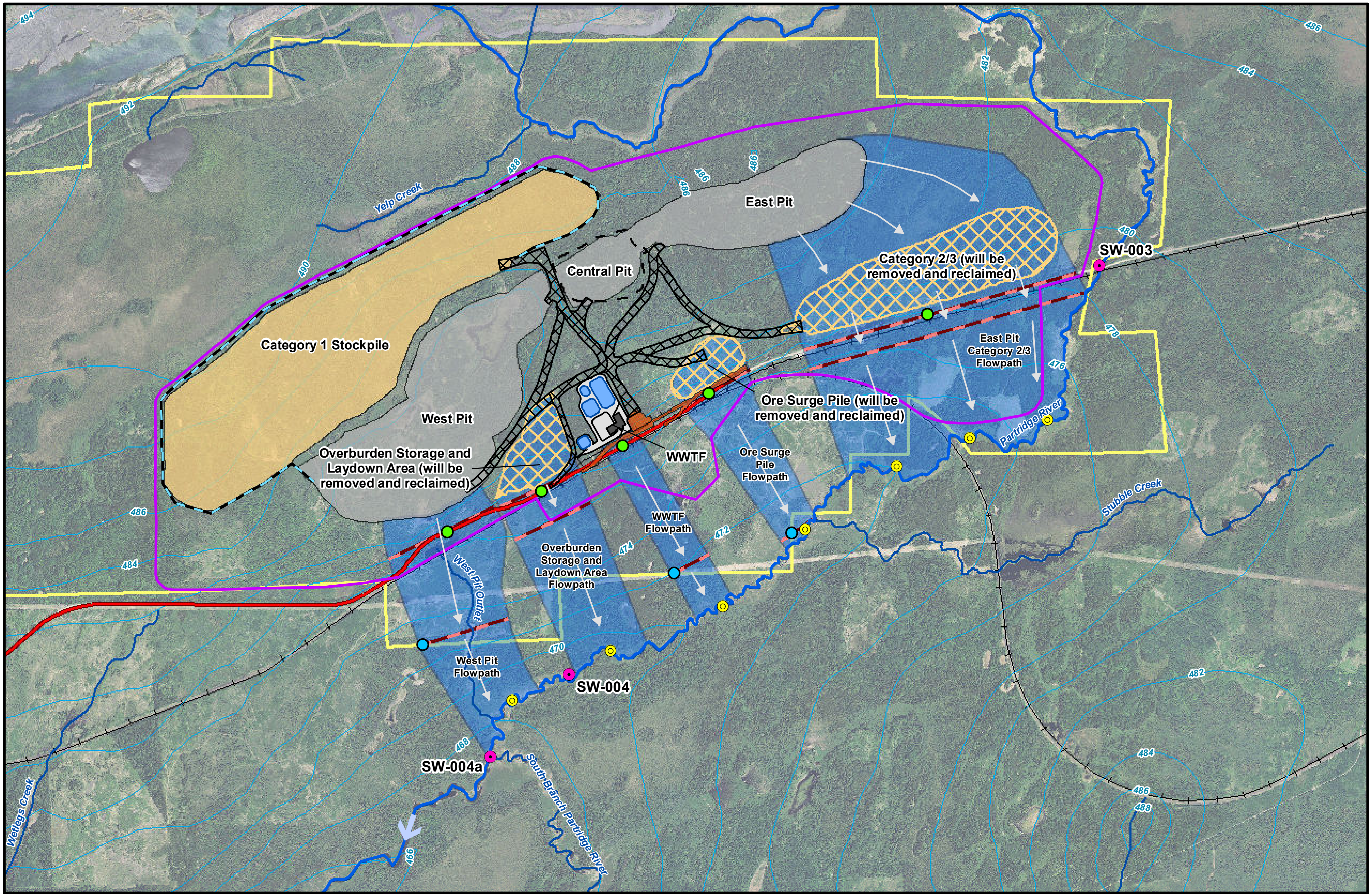

Groundwater Evaluation Locations
Surficial Aquifer Head Contour (m) at Closure
Groundwater Flowpath
Surface Water Modeling/Monitoring Stations
Groundwater Discharge to Surface Water
Groundwater Evaluation Point
Groundwater Reporting Location
Groundwater Containment System
Permanent Stockpiles
Removed and Reclaimed Stockpile
Removed Stockpile
Extent of Future PolyMet Lands
Surface Water Flow
Mine Site
Haul Road
Mine Pit
Groundwater Flow
Dunka Road
Stream/River

Minnesota Department of Natural Resources
US Army Corps of Engineers St Paul District
Forest Service U.S. Department of Agriculture

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N W E S

0 1,000 2,000 4,000 Feet

Figure 5.2.2-4

Mine Site Surficial Groundwater Flowpaths

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Table 5.2.2-8 Mine Site Surficial Groundwater Flowpaths used in GoldSim Based on Deterministic and P50 Inputs

		Chemical Source to Groundwater					
Description	**Units**	**West Pit**	**Overburden Storage and Laydown Area**	**WWTF**	**Ore Surge Pile**	**Category 2/3**	**East Pit**
Groundwater flow rate from contaminant source into the upgradient portion flowpath	gpm	6.1[1]	14.0	0.0135	0.00116	0.0193	3.75[1]
Net meteoric recharge flux	in/yr	0.828	0.993	0.647	0.903	0.910	0.910
Flowpath width	meters	665	550	240	430	1440	1440
Flowpath total length	meters	1,505	1,600	1,730	1,415	2,120	2,120
Recharge flow rate into flowpath	gpm	10.58	11.16	3.43	7.01	35.47	35.47
Groundwater discharge rate into Partridge River	gpm	16. 7	22.56 [11.1[2]]	3.4	7.0	35.5	39.3
Flowpath thickness	meters	5	5	5	5	5	5
Aquifer porosity	(--)	0.30	0.30	0.30	0.30	0.30	0.30
Chemical source begin time	mine year	33	0	0	0	0	21
Chemical source end time	mine year	Continuous	21	37	21	21	Continuous
Distance from contaminant source to mine property boundary (groundwater evaluation point)	meters	860	235	910	1,085	140	1,345
Sharp front contaminant arrival time at property boundary (based on contaminant source begin time)	mine year	65	6[3]	75	90	12	90
Distance from contaminant source to Partridge River (surface water discharge)	meters	1505	1225	1310	1185	955	2,120
Sharp front contaminant arrival time at Partridge River (based on contaminant source begin time)	mine year	90	17[3]	95	90	30	110

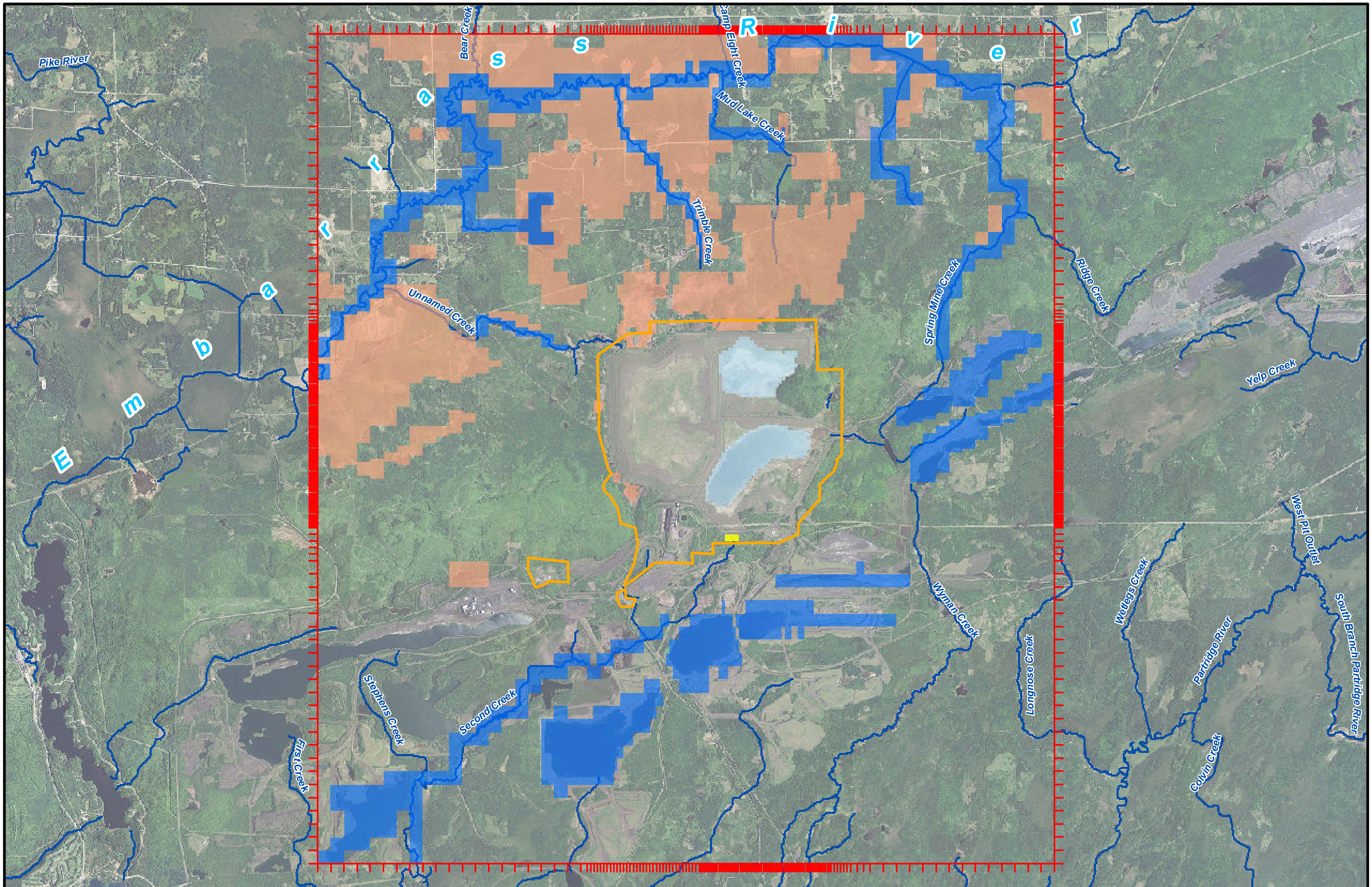
Source: Barr 2013f; ERM 2013

[1] Pit Water into groundwater flowpath
[2] After source removed at 21 years
[3] Concentration decrease for most constituents

Plant Site

The Plant Site MODFLOW model was constructed with two layers and simulated groundwater flow in tailings materials, the underlying surficial groundwater system, and in bedrock. The aerial extent of the Plant Site MODFLOW model and simulated hydrologic features are shown on Figure 5.2.2-5. The model was used to estimate:

- hydraulic conductivities of natural surficial materials, tailings, and bedrock;
- aerial recharge;
- specific yield; and
- distribution of tailings seepage to different segments of the Tailings Basin perimeter.



Plant Site
River Cell - Layer 2
Constant Head Cell Layer 1
Drain Cell - Layer 2
Constant Head Cell Layer 2
Model Grid

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N E S W

0 0.5 1 2 Miles

Figure 5.2.2-5
Plant Site MODFLOW Model - Extent and Boundary Conditions
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Model calibration was performed by varying input hydraulic conductivities, specific yields, and recharge so that model-predicted hydraulic heads were a reasonable match to water levels measured in monitoring wells. An initial steady-state calibration was performed using operational and water-level data from early 2002 to simulate groundwater mounding conditions near the end of LTVSMC operations. Then, a transient calibration was performed to simulate the observed dissipation of the groundwater mound from 2002 to 2011. A description of the MODFLOW model and calibration process is provided in the Plant Site Water Modeling Data Package (Barr 2013i, Attachment A). The MODFLOW-calibrated hydraulic parameters for different geologic units and tailings types are summarized in Table 5.2.2-9 and Table 5.2.2-10.

Table 5.2.2-9 Plant Site Hydraulic Conductivity and Specific Yield Based on MODFLOW Calibration

Model Zone	Hydraulic conductivity		Specific yield (---)
	Horizontal (ft/day)	Vertical (ft/day)	
Cell 2W fine tailings	0.312	0.158	0.024
Cell 2W coarse tailings	3.33	0.0535	0.010
Cell 2W embankments	3.33	0.0535	0.010
Cell 1E fine tailings	0.0779	0.0500	0.10
Cell 1E coarse tailings	6.81	0.802	0.20
Cell 2E fine tailings	0.247	0.200	0.054
Cell 2E coarse tailings	6.35	0.702	0.10
Cell 2E embankments	6.35	0.702	0.10
Surficial deposits	71.3	28.5	0.0002
Bedrock outcrops	0.0493	0.0207	0.20

Sources: Barr 2013i; Barr 2013j.

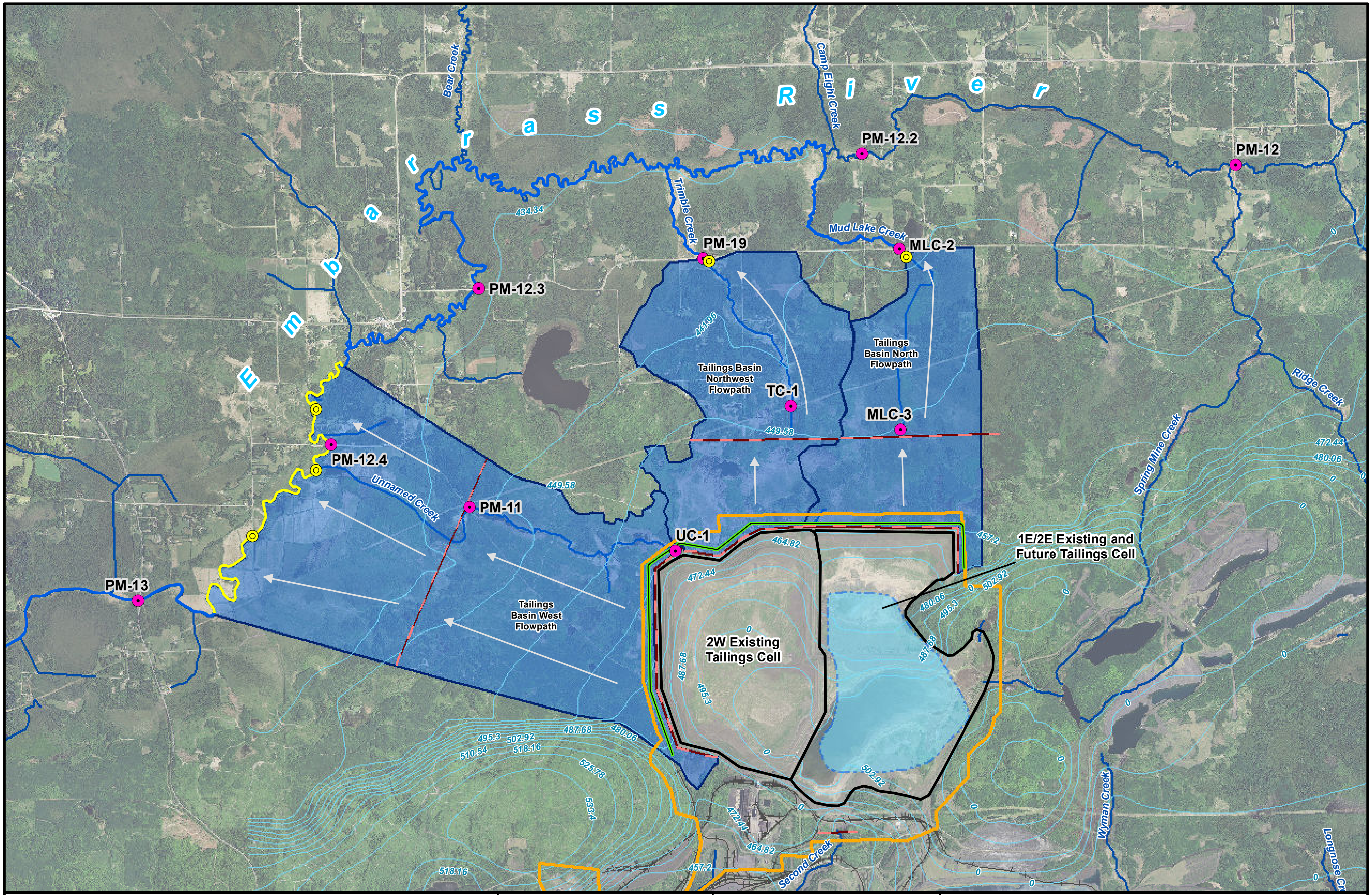
Table 5.2.2-10 Plant Site Recharge Based on MODFLOW Calibration

Model Zone	Recharge	
	Steady-State Calibration (in/yr)	Transient Calibration (in/yr)
Exterior dams	6.0	6.0
Cell 2W interior slopes	12.0	11.0
Cell 2W interior tailings	26.1	18.0
1E and 2E fine tailings	1.0	1.0
1E and 2E coarse tailings	6.0	6.0
Surficial deposits	6.0	6.0
Bedrock outcrops	1.0	1.0

Sources: Barr 2013i; Barr 2013j

After calibration was completed, the Plant Site MODFLOW model was used to evaluate groundwater conditions associated with the NorthMet Project Proposed Action. These predictive simulations evaluated the growth/decay of the groundwater mound below the Tailings Basin and the distribution of groundwater flows from subareas of the Tailings Basin to the north, northwest, west, and south toes of the Tailings Basin.

Figure 5.2.2-6 shows surficial groundwater flowpaths incorporated into the GoldSim model that have the potential to transport mine affected groundwater from contaminant source areas to the Embarrass River or its tributaries. Also shown are the mutually agreed upon groundwater evaluation locations (property boundary) used to assess compliance with evaluation criteria. The hydrologic characteristics of each surficial flowpath are estimated based on a combination of the MODFLOW results and field measurements. Deterministic GoldSim inputs include length, average width, saturated thickness, hydraulic gradient (essentially ground slope), and effective porosity. Uncertain inputs are hydraulic conductivity and net meteoric recharge.



Groundwater Evaluation Locations
Groundwater Elevation Contours
Surface Water Evaluation Locations
Groundwater Discharge to Surface Water
Groundwater Discharge to Surface Water
Groundwater Flowpath
Plant Site
Existing Tailings Basin
Approximate Pond Area
Containment System
Groundwater Flow
Stream/River

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N E S W

0 0.25 0.5 1 1.5 Miles

Figure 5.2.2-6
Plant Site Surface and Groundwater Flowpaths and Final Tailings Design
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Summary information for the GoldSim groundwater flowpaths is provided in Table 5.2.2-11. Based on deterministic inputs and 50 percent probability (P50) values for uncertain inputs including hydraulic conductivity and recharge; the estimated total discharge rate of flowpath groundwater into the Embarrass River is 292 gpm.

Table 5.2.2-11 Plant Site Groundwater Flowpaths used in GoldSim Based on Deterministic and P50 Inputs

		Surficial Aquifer Pathway		
Description	**Units**	**West**	**Northwest**	**North**
Groundwater flow rate approaching containment system	gpm	102.5	51.2	40.7
Containment system capture efficiency	%	90	90	90
Groundwater flow rate bypassing containment system	gpm	10.2	5.1	4.1
Net meteoric recharge flux	in/yr	0.765	0.765	0.765
Flowpath width	m	2920	2090	1920
Total distance from containment system to location of groundwater discharge to surface water	m	5,331	3,645	3,191
Recharge flow rate to flowpath downgradient of containment system	gpm	152.1	74.4	59.8
Groundwater discharge to surface water (Embarrass River or its tributaries)	gpm	162.3	79.5	63.9
Flowpath thickness	m	7	7	7
Aquifer porosity	(--)	0.30	0.30	0.30
Distance from containment system to property boundary	m	3023	1250	1132
Sharp-front contaminant arrival time at property boundary	yr	242	193	197
Sharp-front contaminant arrival time at the location of groundwater discharge to surface water	yr	298	296	298

Source: ERM 2013.

5.2.2.2.2 Surface Water Hydrologic Modeling

This section describes the methods used to model surface water hydrology in the Partridge River and Embarrass River watersheds.

Partridge River Watershed

Surface water flow within the Partridge River Watershed was modeled using the XP-SWMM model, which is a public-domain watershed hydrology model that estimates storm runoff, stream flow, and groundwater-controlled base flow for a network of streams. Input to the model includes subdrainage delineation, ground conditions, stream channel alignments, and a synthetically generated rainfall database. XP-SWMM estimates monthly average stream flow rates at different locations along the Partridge River and its important tributaries. To improve the results, the model inputs (mainly runoff parameters) were adjusted so that flow estimates were calibrated to available measured flow rates in the Partridge River. A description of the XP-SWMM model for the Mine Site is provided in the Mine Site Water Modeling Data Package

(PolyMet 2013j). A summary of the model results for seven Partridge River monitoring stations (Figure 4.2.2-8) is provided in Table 5.2.2-12.

Table 5.2.2-12 Mine Site Surface Water Flows for Existing Conditions[1]

Stream	Station	Baseflow	10-year[2] Low Flow	Average Annual Low Flow	Average Annual Flow	Average Annual High Flow	10-year[2] High Flow
		cfs	cfs	cfs	cfs	cfs	cfs
Partridge River	SW-002	0.4	0.4	0.4	6.1	82	118
	SW-003	0.5	0.5	0.5	7.4	93	132
	SW-004	0.9	0.7	0.9	14	156	215
	SW-004a	2.4	1.7	2.1	38	468	678
	SW-004b	3.8	2.8	3.4	58	631	895
	PM-4/SW-005	4.9	3.6	4.3	75	737	1,081
	SW-006	5.3	3.9	4.7	79	762	1,127

Source: PolyMet 2013j

Notes:

1 Based on existing-conditions XP-SWMM model results adjusted using scale factors listed in Table 4-7 of the Mine Site Water Modeling Data Package (PolyMet 2013j).

2 10-year values are based on individual model years flow statistics not published in Attachment G. Values in Attachment G represent averages of 10-year model period.

Embarrass River Watershed

Flow characteristics for different reaches of the Embarrass River and selected tributaries were estimated by extrapolating flows from USGS gaging station 04017000 (located just downstream of PM-12.3) on a unit-area basis. A summary of the flow results for different stations on Embarrass River, Mud Lake Creek, Trimble Creek, and Unnamed Creek is provided in Table 5.2.2-13.

Table 5.2.2-13 Plant Site Surface Water Flows for Existing Conditions including Tailings Basin Seepage and Flowpath Discharge Based on Embarrass River Stream Gauging Results Applied to Contributing Watersheds

Stream	Station	Estimated Baseflow	20-Year Annual Low Flow	Average Annual Low Flow	Average Annual Flow	Average Annual High Flow	20-Year Annual High Flow
		cfs	cfs	cfs	cfs	cfs	cfs
Embarrass River	PM-12	0.9	0.2	0.7	14	145	370
	PM-12.2	1.6	0.4	1.4	26	268	684
	PM-12.3	7.1	4.2	6.6	65	644	1,638
	PM-12.4	7.6	4.3	7.0	73	731	1,860
	PM-13	9.4	5.6	8.7	83	824	2,096
Mud Lake Creek	MCL-3	0.5	0.5	0.5	1.5	11	28
	MLC-2	0.7	0.6	0.7	3.2	28	70
Trimble Creek	TC-1	2.7	2.6	2.7	4.2	19	45
	PM-19	2.9	2.8	2.9	5.6	33	80
Unnamed Creek	UC-1a	1.1	1.0	1.1	2.6	18	46
	PM-11	1.1	1.0	1.1	3.4	27	67

Source: Barr (pers. comm., March 8, 2013).

5.2.2.2.3 Water Quality Modeling (GoldSim)

GoldSim is a commercially available "systems" model that was programmed by PolyMet to simulate time-varying surface water and groundwater quality. GoldSim was programmed with a suite of complex algorithms to estimate the release of contaminants from mine facilities (i.e., "sources") and their transport to groundwater and surface water evaluation locations. An overview of the modeling of contaminant release and transport in GoldSim is provided below. In the sections below we provide a geochemistry overview of the waste rock and tailings, and describe the methodology used to estimate contaminant release and transport at the Mine Site (Partridge River Watershed) and Tailings Storage Facility (Embarrass River Watershed).

Mine Site (Partridge River Watershed)

This section describes the geochemistry of the NorthMet Deposit waste rock and the factors affecting contaminant release and transport from the various contaminant sources at the Mine Site. An overall flowchart of the Mine Site GoldSim model is shown on Figure 5.2.2-7.

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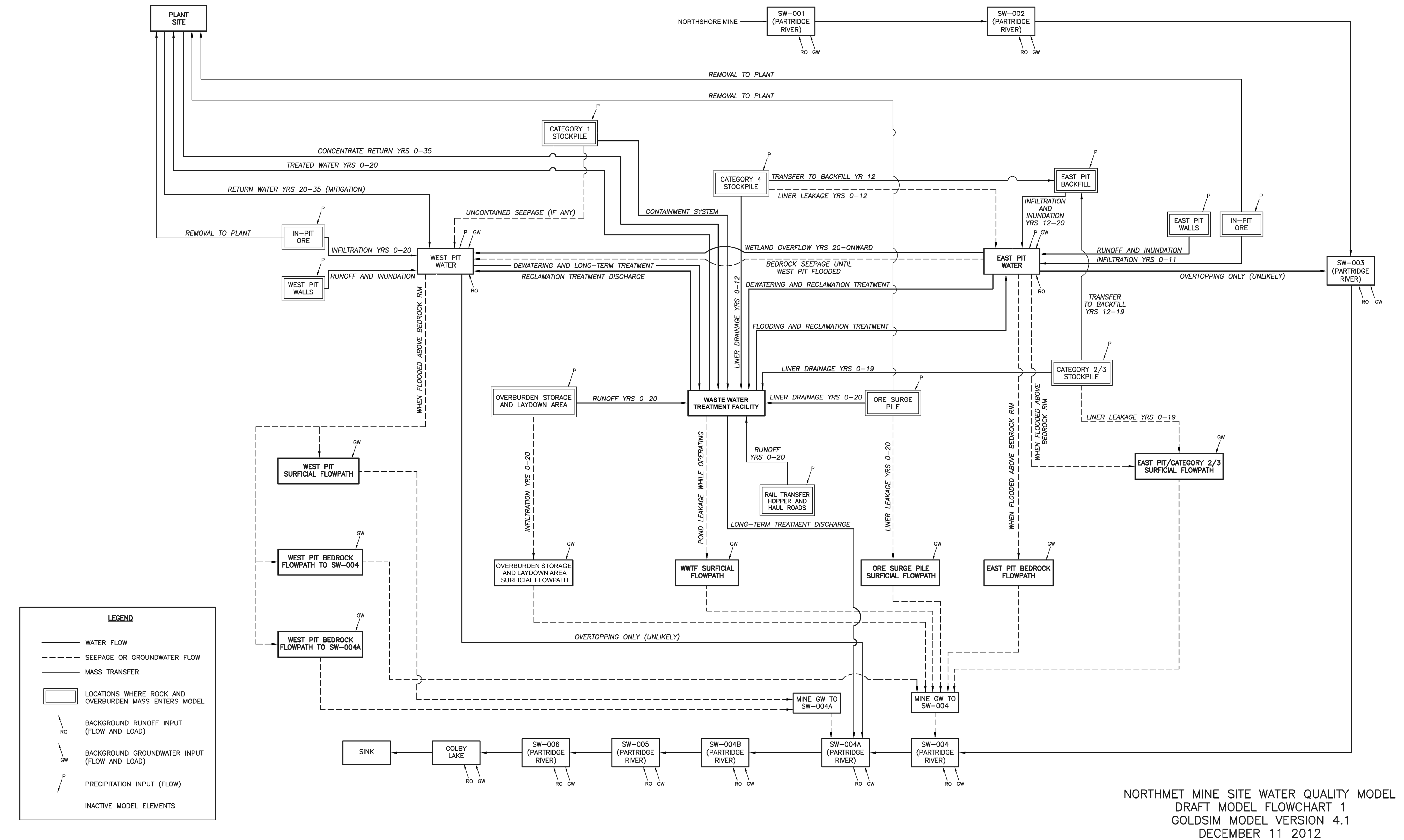

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Figure 5.2.2-7
Mine Site GoldSim Flow Chart
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NorthMet Waste Rock Geochemistry

The mechanism most responsible for the release of solutes from waste rock is oxidation of sulfide minerals, primarily pyrrhotite (FeS) in NorthMet Deposit rock. The sulfide-oxidation reaction produces sulfuric acid, and releases soluble metals (e.g., cobalt, copper, iron, and nickel) that were bound in sulfide minerals. Secondary effects include leaching of some metals (primarily nickel and chromium) from silicate minerals, particularly where acidic pore waters increase silicate solubility. Blasting and excavation dramatically increases the oxidation rate by increasing the surface area and porosity of the rock, which allows rapid introduction of atmospheric oxygen and flushing of solutes by water. Where the pore water pH remains near-neutral, metal mobility can be limited as some metals released by oxidation are removed from solution by adsorption or co-precipitation. The onset of acidic pore water is also problematic, as these conditions cause the rate of sulfide oxidation to increase and the concentration of metals to increase as precipitates dissolve.

Key environmental characteristics of the NorthMet waste rock include the following:

- most of the waste rock and pit wall rock would contain some sulfide sulfur, mainly as mineral pyrrhotite (FeS), which can produce acid leachate and soluble metals when it oxidizes;
- there are essentially no acid-neutralizing carbonate minerals in NorthMet waste rock, but silicate minerals neutralize some acid, which would delay acid onset;
- in rock with less than 0.12 percent sulfur (S), the oxidation rate is slow enough that all acid produced during weathering would be completely neutralized by reaction with silicate minerals, so this low-sulfur rock (classified at Category 1 waste rock in the NorthMet Project Proposed Action) is predicted to never generate acidic leachate;
- sulfide-bearing rock from the NorthMet Project Proposed Action may oxidize for several years before producing acidic leachate;
- the rate of sulfide mineral oxidation in excavated NorthMet waste rock would be approximately proportional to the total sulfur content of the material, and the rate can increase several fold if the pore water would become acidic;
- chemical reactions, including mineral precipitation and surface adsorption, would limit the concentration of many contaminants in non-acidic waste-rock effluent and thus would reduce the rate at which contaminants are released; and
- the concentration of some metal cations in waste rock effluent (e.g., nickel and copper) would increase dramatically if the pH shifts from neutral to acidic, dissolving metals bound to solids.

The environmental classification of NorthMet waste rock is based primarily on the sulfur concentration, and the distribution of sulfur through the deposit is based on spatial interpolation between 19,661 analyses of rock samples collected as part of the exploration drilling (SRK 2007a). Rates of oxidation and contaminant release are based on 102 “humidity cell” tests, which measured solute concentrations in leachate as rocks were subjected to several years of weekly weathering cycles. These include tests on 85 waste rock samples of Category 1 through Category 4 waste rock and ore from the NorthMet Deposit that include samples from each type of waste (PolyMet 2013l, Attachment A, Table 2). Estimates for changes in oxidation rates and solute release during long-term weathering were supplemented with 17 independent tests conducted by the MDNR on rock from a similar proximal deposit (the Dunka Blast Hole). These tests on Dunka rock used smaller fragment size rock (termed "MNDNR Reactors"), and results were used to refine estimates of oxidation-rate changes during weathering (PolyMet 2013l, Attachment A, Table 3). Total leachable metal concentrations are based on 61 analyses of metals extracted from waste rock by acidic digestions (SRK 2007b). Finally, the concentration of metals in mineral phases was based on electron microprobe analysis, which measured the concentration of metals in 630 individual mineral grains (74 oxides, 268 sulfides, and 288 silicates [SRK 2007b; SRK 2007c]).

These environmental characteristics have been used to classify NorthMet waste rock into the following four environmental categories (PolyMet 2013l, Figure 4-8]):

- Category 1: Sulfide S range = 0.01 to 0.12 percent, would not produce acidic leachate.
- Category 2/3: Sulfide S range = 0.13 to 0.60 percent, could produce acidic leachate if allowed to weather for several years.
- Category 4 (Duluth Complex): Sulfide S range = 0.63 to 3.05 percent, could produce acidic leachate if allowed to weather for several years.
- Category 4 (Virginia formation): Sulfide S range = 0.4 to 5.0 percent, could produce acidic leachate immediately upon weathering.

Ore would behave similar to Category 4 Duluth complex waste rock, but, other than residual ore in pit wall rock, would not remain on the surface for any extended periods, as it would be quickly collected after blasting and transported to the processing plant.

The sulfide S concentration of the NorthMet waste rock is relatively low compared to many other sulfide mines around the world. Data from the International Kinetic Database, which includes humidity cell test results from 71 mines, shows sulfide S concentrations ranging as high as 40 percent, with an average of 3.6 percent (Figure 5.2.2-8) (Minesite Drainage Assessment Group 2013). In comparison, most (70 percent) of the NorthMet waste rock would be the low-sulfur, non-acid-generating Category 1 material (i.e., average sulfur would equal 0.06 percent, and range from 0.01 to 0.12 percent). The average mass-weighted sulfur content in all NorthMet waste rock is only 0.15 percent, which is also low relative to the average sulfide S concentration of 3.6 percent in the International kinetic database. The only NorthMet waste rock that would contain greater than 1 percent sulfide is the Virginia Formation, which has an average sulfide S concentration of 2.43 percent and which would comprise about 1.8 percent of the total NorthMet Deposit waste rock.

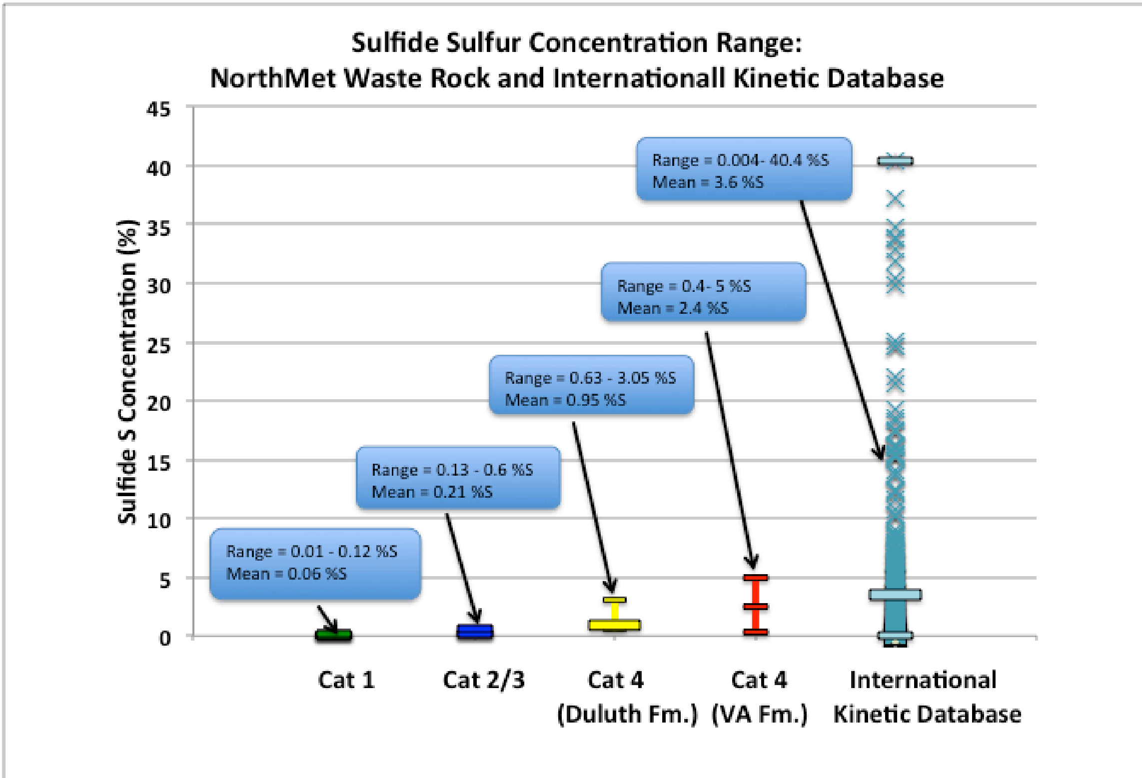

Figure 5.2.2-8 Sulfide Sulfur Concentration Range Comparison: NorthMet Waste Rock and International Kinetic Database

Constituent Release from Waste Rock

The GoldSim model simulates constituent release from waste rock based on simplifying assumptions that extrapolate from conditions observed in laboratory tests in order to provide quantitative estimates of loading that are then combined with hydrologic estimates to predict solute concentrations. The predictive models assume that the entire mass of waste rock in each of the stockpiles is oxygenated and is thus capable of reacting with air (some waste rock can have zones with lower than atmospheric oxygen concentrations, so this assumption tends toward producing higher rates of pollutant release than may exist). Field oxidation rates are then estimated by scaling from lab rates to account for effects of temperature (oxidation is slower at the lower on-site temperatures), fragment size, and the fraction of rock flushed by percolating water. The rate of contaminant release is modeled as a load rate (e.g., mg contaminant per month), estimated as the product of the mass of the waste (kg waste) and the rate of contaminants are released (mg contaminant/kg waste per month).

This transport simulation assumes that solutes released by oxidation can dissolve when contacted by rain and snowmelt percolating through the waste rock, and dissolved constituents are flushed immediately through the rock. Where the concentration of contaminants in percolating water is not limited, the entire load released over a time step can dissolve in any available water. In this case, decreasing the water flow would still collect the entire contaminant load, producing a more concentrated leachate, but the same solute load rate. In most NorthMet waste rock, however, contaminant concentrations are limited by “concentration caps”—empirical upper-concentration values based on measured conditions in waste rock from the NorthMet Deposit or other similar deposits. When solute concentrations are capped in modeling, then solute loads are proportional to flow rate, so that reduced flow rates would result in a proportional reduction in solute load to the environment. The Category 1 Stockpile is the clearest example of this effect, because solutes would be released over time by oxidation, but the pore water would maintain at a near-neutral pH, where many solutes have limited solubility. (The effect of concentration caps in the Category 1 Stockpile would be further enhanced in long-term closure, when a proposed geomembrane cover would reduce infiltration, producing a proportional reduction in the load rate of those solutes at their pore-water concentration caps.) The GoldSim model tracks the total mass of these capped solutes, so that constituents removed from solution to meet concentration caps are retained in a temporarily immobile phase, and allowed to leach later when solute concentrations eventually drop below the concentration caps. In contrast, for the more acid-generating materials, including the ore and Category 4 waste rock, concentration caps are much higher or non-existent, and load to the environment is more closely related to the rate of contaminant production regardless of water flow rate through the waste.

Detailed descriptions of the assumptions and algorithms used to estimate solute release from mine-related facilities is provided in the Waste Characterization Data Package (PolyMet 2013l).

Contaminant Transport from Waste Rock

Once most of the contaminants are released, they are assumed to travel in the same direction and rate as groundwater, although accounting for some dispersion, and ultimately emerging in surface water. Groundwater flow rates and flow directions in the model were taken directly from the MODFLOW results or were programmed to be consistent with the MODFLOW results. Time-varying surface water flow rates were taken either from the XP-SWMM results or were estimated from stream gauging data.

Some solutes, however, travel through the aquifer at a slower rate than the flowing water. This effect, called "attenuation," is caused by the adsorption of solutes onto the surface of the aquifer matrix (referred to as sorption), which is the mass of fine-grained or fractured rock in an aquifer that stores the largest amount of groundwater,. Four solutes are assumed to be attenuated at the NorthMet Project area and in the GoldSim model: arsenic, antimony, copper, and nickel due to their high metal partition coefficients. 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.

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). In addition, 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 2009h). Table 5.2.2-14 presents the USEPA literature values, the results of the site-specific sorption testing, and the K_d values accepted for use in groundwater modeling.

Table 5.2.2-14 Comparison of Site-specific and Literature Sorption Values[1] at the Mine Site

Parameter	USEPA K_d Screening Value Used in DEIS	Site-specific Sorption (K_d) Values (a)			K_d used in GoldSim Model	Associated Retardation Factor used in GoldSim Model (b)
		Boring RS-22	Boring RS- 24	Average		
	(liter/kg)	(liter/kg)	(liter/kg)	(liter/kg)	(liter/kg)	(---)
Antimony	45	1.6	22	12	1.3, 1.6, 6.1 (c)	7.5, 9.0, 31 (c)
Arsenic	25	>52	590	~320	25 (d)	126 (d)
Copper	22	1,047	463	755	22 (d)	111 (d)
Nickel	16	73	40	56	16 (d)	81 (d)

[a] Modified from: Barr 2009h.
[b] Assuming porosity of 0.3 and dry bulk density of 1,500 kg/m^3.
[c] Uncertain input with triangular distribution. Minimum, mode, and maximum values, respectively.
[d] Deterministic value.

The attenuation effect resulting from sorption is significant enough that, in the GoldSim model of the Mine Site, none of these four contaminants is predicted to travel from the source areas to evaluation locations (property boundary or Partridge River) within the 200-year model simulation period.

Among these four attenuated contaminants, antimony has the lowest partition coefficient, and is the only one expected to discharge to surface water within the model simulation period. The modeled antimony discharge to surface water is predicted to occur in the West Pit Flowpath, which has the shortest distance of any of the flowpaths between a contaminant source areas (i.e., the West Pit) to a model prediction location (i.e., Dunka Road), approximately 860 ft.

The model results show that at the end of the 200-year modeling period, antimony concentrations would still be increasing at Dunka Road and would not yet reach the Partridge River. PolyMet conducted a separate 1,000-year model simulation for antimony at the West Pit Flowpath. Results of this longer simulation indicated that the maximum antimony concentration in groundwater at the evaluation location (i.e., property boundary) would be 3.5 µg/L, which is below the evaluation criterion (6.0 µg/L), and would not reach the evaluation location until approximately year 450 (Figure 5.2.2-9).

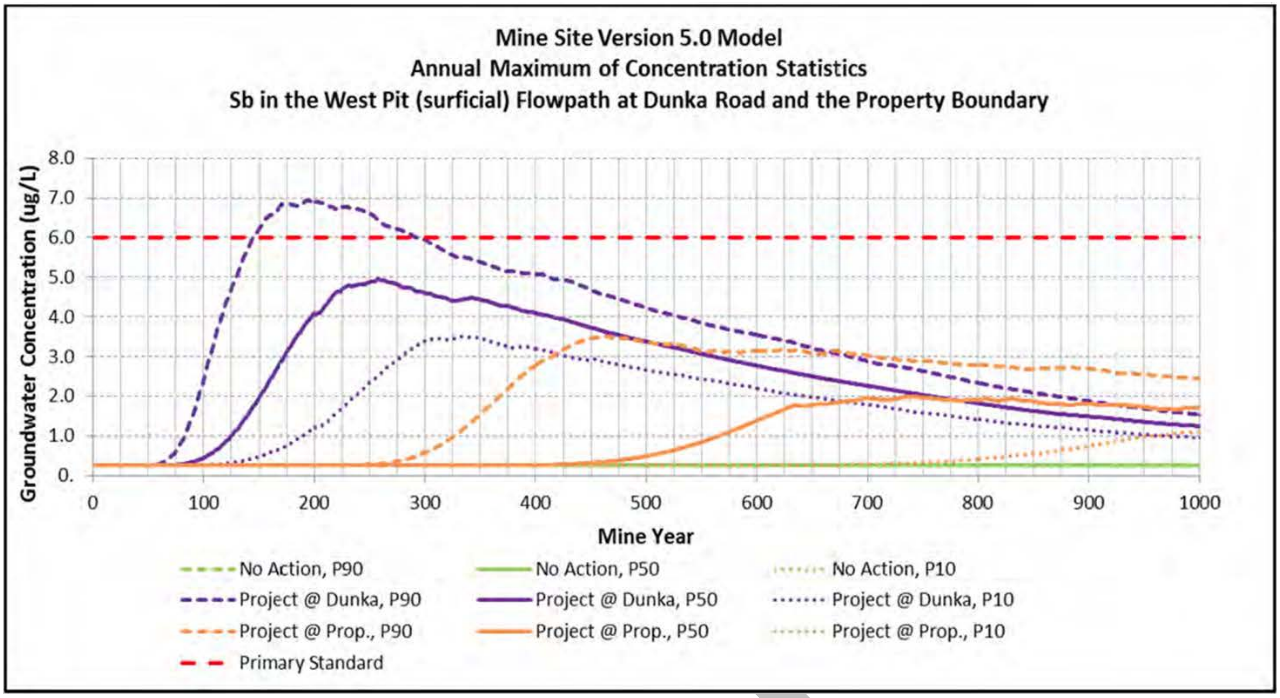

Figure 5.2.2-9 Concentrations of Antimony in the West Pit Surficial groundwater Flowpath at Dunka Road and the Property Boundary: 1,000 Year Model Run

The other attenuated contaminants (i.e., arsenic, copper, and nickel) would take much longer to discharge to surface water (i.e., up to approximately 3,150 years for arsenic) because they have significantly larger partition coefficients.

Tailings Basin (Embarrass River Watershed)

The GoldSim software has been programmed to incorporate surface water flow, contaminant release from tailings, groundwater transport of bypass from the containment system to the Embarrass River system, Tailings Basin pond overflow, water transfers between mine facilities, and discharge of WWTF-treated effluent to the Embarrass River system. An overall flowchart of the GoldSim model is shown on Figure 5.2.2-10. This section describes the geochemistry of the NorthMet Project Proposed Action tailings and the factors affecting contaminant release and transport from the Tailings Basin.

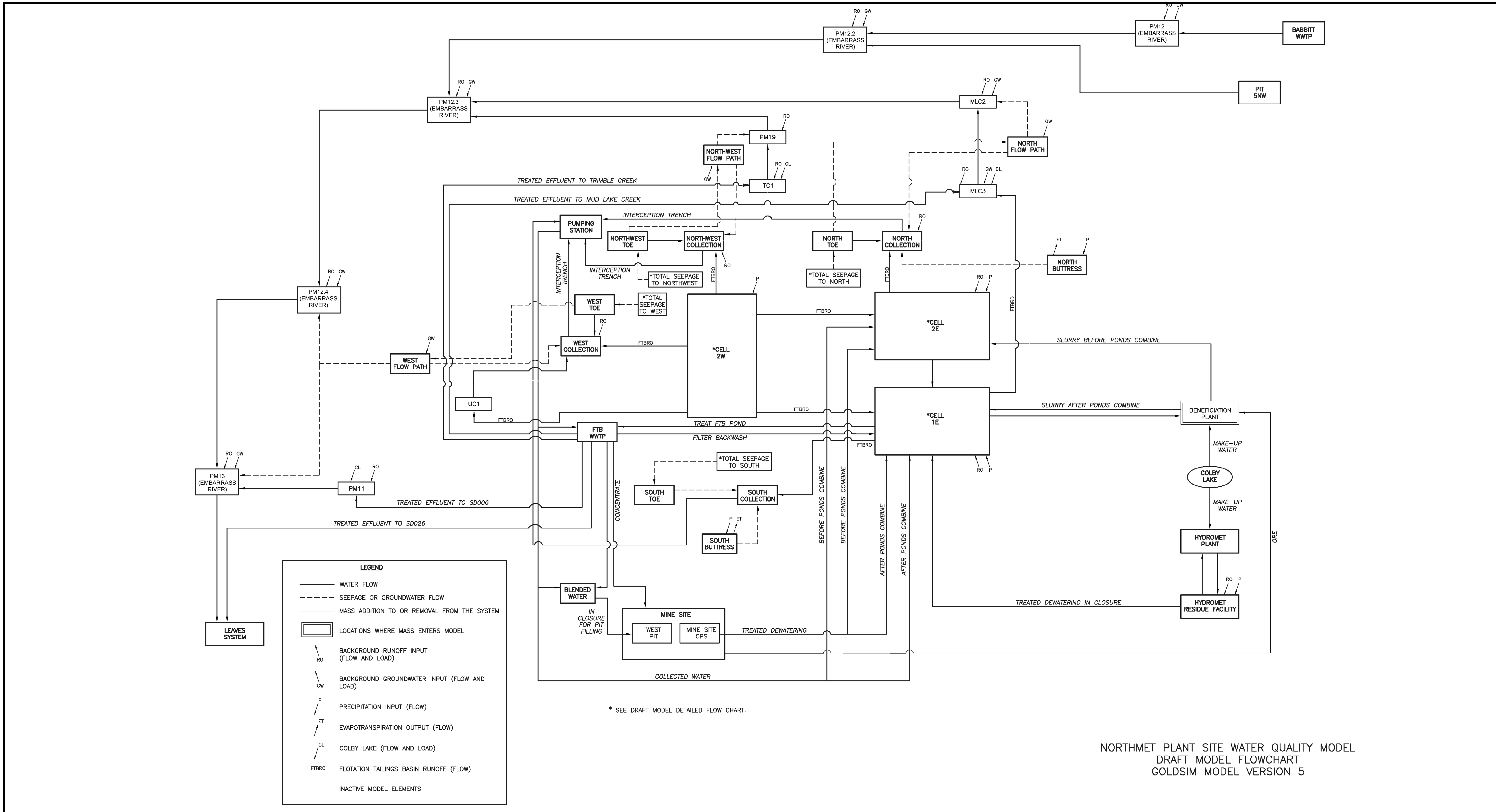

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Figure 5.2.2-10
Plant Site GoldSim Flow Chart
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NorthMet Tailings Geochemistry

The NorthMet Project Proposed Action tailings are predicted to have less than 0.12 percent sulfur, which kinetic tests demonstrate is low enough that it would never produce acidic leachate (PolyMet 2013l). The bulk sulfide flotation process used in handling the ore would maintain the sulfide S below 0.12 percent in the tailings discharged to the Tailings Basin.

The assumptions regarding the environmental behavior of the tailings are based on 33 samples that were generated in pilot-plant processing tests conducted to refine the metal recovery process. The tailings samples were analyzed to determine concentrations of total metals, acid-generating sulfur, and acid-neutralizing carbonate carbon; and were then subjected to humidity cell testing (PolyMet 2013l, Attachment E, Table 1). The estimates of tailings effects on water quality presented in this SDEIS are based largely on the results from these humidity cell tests at the point when they had run continuously for between 90 and 300 weeks.

Tailings samples subjected to humidity cell tests included a range of sulfide S concentrations (0.06 to 0.24 percent S) and size fractions selected to represent the ranges expected under various depositional environments in the Tailings Basin (SRK 2007c):

- dam material (greater than 0.152 mm),
- beach (greater than 0.152 to 0.076 mm), and
- fine sands (less than 0.076 mm).

Results of the humidity cell tests on pilot-plant tailings had similar results to Category 1 waste rock, with sulfate release rates increasing roughly in proportion to total sulfur, and declining sulfate production over time as the sulfide minerals are consumed (PolyMet 2013l, Attachment E, Figure 5). The GoldSim model estimates the moisture content in the tailings and dams materials through time, and uses this to estimate the oxidation rate of sulfide minerals and the associated release of solutes.

The predicted concentration of contaminants in tailings seepage is limited by “concentration caps.” Concentration caps are empirical upper-concentration values based on measured conditions in rock from the NorthMet Deposit or other similar deposits. For solutes modeled at their concentration caps, the load leaving the tailings would be proportional to water flow; but the GoldSim model tracks the mass of contaminants stored in the tailings, so reductions in predicted discharge loading due to concentration cap limits are balanced by a longer total duration of contaminant release.

The pH of effluent from oxidizing tailings ranges between 6 and approximately 8.3, though the pH in effluent from tailings with sulfur similar to that of the Tailings Basin (sulfur approximately 0.12 percent) is generally above 7 (PolyMet 2013l). Decreases in pH are associated with increases in the concentrations of metal cations, such as nickel. By the end of the longest humidity cell tests (300 weeks), the pH in most tailings effluent was increasing, suggesting that the pH would not become acidic. Under oxygenated conditions at room temperature, oxidation of the tailings releases between approximately 2 and 8 mg SO_4/kg tailings per week.

Finally, acid base accounting and humidity cell tests were also conducted on the existing LTVSMC tailings, which would underlie the NorthMet Project Proposed Action tailings. These were produced from a separate deposit, and contain enough carbonate minerals to be net-neutralizing, so are a low risk of producing acidic leachate. Leachate from humidity cell tests produced stable pH (between 7.3 and 8.1) and stable release rates for the primary constituents of concern, which were used as the basis of predicting solute release under field conditions (PolyMet 2013l, Attachment E).

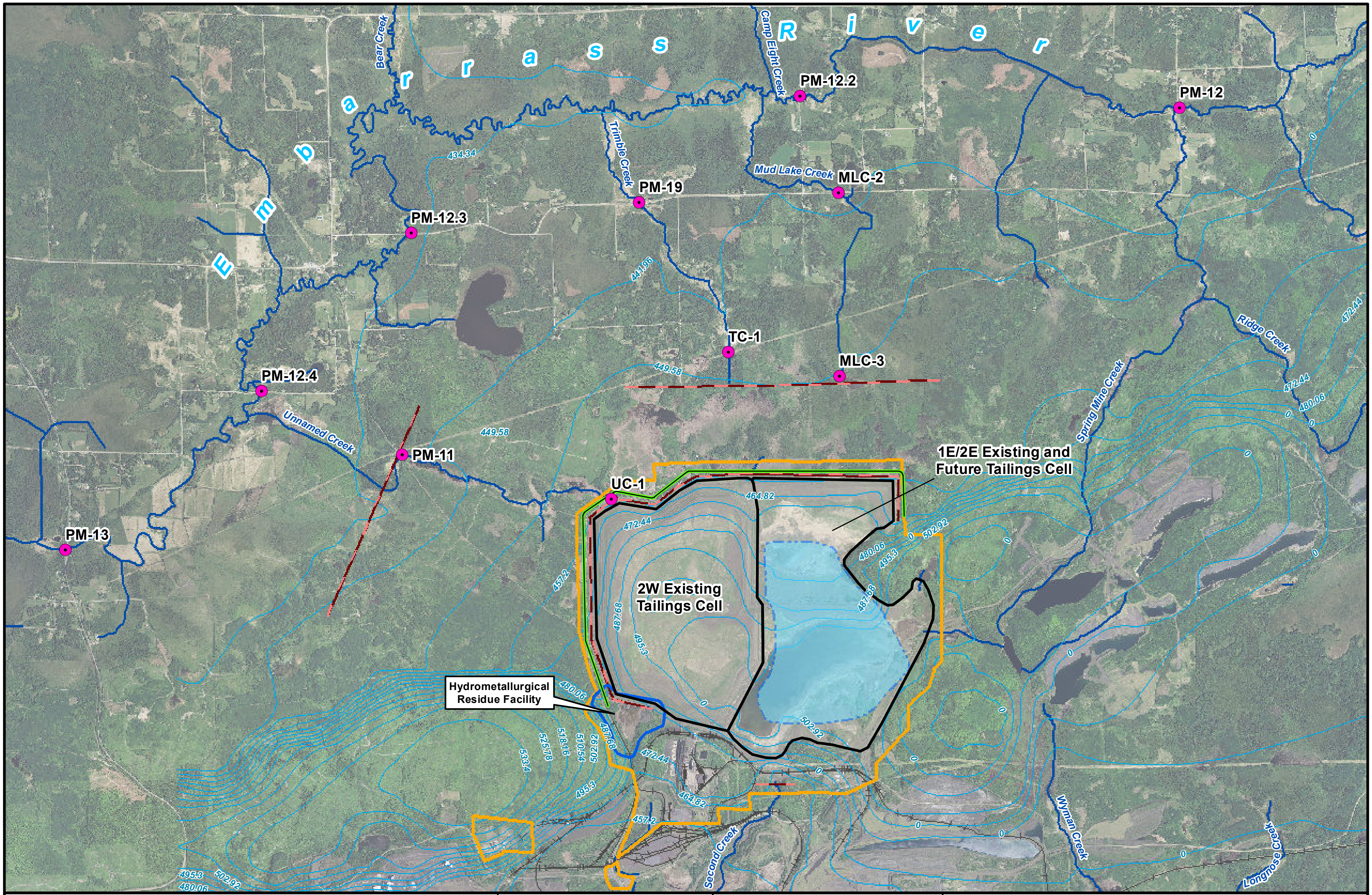
Flowpaths within the tailings, from the surface and through the unsaturated and saturated tailings areas, were estimated using groundwater flow models, and these pathways were used to route the solutes released by oxidation in the tailings to the appropriate discharge region.

Contaminant Release from the Tailings Basin

Figure 5.2.2-11 is a base map of the Plant Site showing the tailings facilities that have the potential to be contaminant sources to groundwater and surface water, including Cell 2W, Cell 1E/2E, and a Tailings Basin pond of varying surface area that would continue to exist on top of Cell 1E/2E. The current tailings in Cell 2W and Cell 1E/2E are referred to as LTVSMC tailings and new tailings generated by the NorthMet Project Proposed Action are referred to as NorthMet tailings.

GoldSim is programmed with algorithms for estimating the release of contaminants from the tailings sources areas. For the NorthMet Project Proposed Action, a groundwater and surface water containment system would be constructed at the beginning of operations along the north and west perimeter of the Tailings Basin to intercept affected water seeping from the facility. GoldSim has been programmed to simulate the hydraulic capture of this system during operations and closure. While the system is designed for 100 percent capture of affected groundwater, it is assumed in the GoldSim model that 10 percent of the approaching groundwater (21 gpm) bypasses the system and continues to migrate toward the Embarrass River.

The physical and material characteristics of each source area are summarized in Table 5.2.2-15. In GoldSim, the overall Tailings Basin is divided into subareas that are described in Table 5.2.2-16. For each subarea, the contaminant release is associated with a particular material including different types of LTVSMC tailings and NorthMet tailings. The contaminant release rate in each subarea is based on characteristics of the underlying material and the rate of atmospheric oxygen diffusion from ground surface. The proposed bentonite amendments to surface soils during operations and closure are intended to reduce oxygen diffusion into the subsurface and thereby decrease contaminant release rates from the underlying materials. Using the GoldSim model for existing conditions, the contaminant release parameters for LTVSMC tailings were calibrated to measured water quality in current tailings seepage and groundwater. NorthMet Project Proposed Action contaminant release parameters are based on a combination of laboratory tests and water quality observations at similar tailings facilities in northern Minnesota. The time-varying chemistry of the tailings pond water is computed during the GoldSim simulation based on evaporation and mixing of rainwater, surface runoff, and NorthMet Project Proposed Action-related water transfers to and from the other mining facilities.



Groundwater Evaluation Distances
Groundwater Elevation Contours
Surface Water Evaluation Locations
Containment System
Stream/River
Plant Site
Existing Tailings Basin
Hydrometallurgical Residue Facility
Approximate Pond Area

Minnesota Department of Natural Resources
US Army Corps of Engineers St Paul District
Forest Service U.S. Department of Agriculture

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N W E S

0 0.25 0.5 1 1.5 Miles

Figure 5.2.2-11
Plant Site Contaminant Source Areas
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Table 5.2.2-15 Tailings Basin Facilities

Facility	Engineered Features	Chemical Mechanisms
2W	Existing LTVSMC tailings facility; would not be used for NorthMet Project Proposed Action. Soil surface has natural vegetation to reduce infiltration. Groundwater containment system would collect groundwater and surface seepage.	Sulfide oxidation and associated release of sulfate and metals.
1E/2E	Existing LTVSMC tailings facility that would receive new NorthMet tailings generated by NorthMet Project Proposed Action. Groundwater containment system would collect groundwater and surface seepage. During closure, surface soils would be amended with bentonite and vegetated to reduce infiltration and oxygen entry.	Sulfide oxidation and associated release of sulfate and metals.
Pond	During closure, pond bottom would be amended with bentonite to reduce seepage.	Seepage of pond water and its associated water quality and dissolved oxygen.

Source: PolyMet 2013f.

Table 5.2.2-16 Tailings Basin Chemical Source Subareas used in GoldSim for Closure

Source Area	Tailings Basin Sub-area	Tailings Material Assumed to Control Chemical Release	Bentonite Amended	Area (acre)	Percolation (a) (in/yr)	Bottom Seepage (gpm)	Basis for Chemical Release Calculations
1E/2E	North Dam banks (outer slopes)	LTVSMC bulk (other)	Operations and closure	249.0	6.07	78.1	Calibration (b)
	East Dam banks (outer slopes)	LTVSMC bulk (other)	Operations and closure	40.0	6.07	12.5	Calibration (b)
	South Dam banks (outer slopes)	LTVSMC bulk (other)	Operations and closure	91.0	6.07	28.5	Calibration (b)
	North Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	75.7	6.07	23.7	Lab/other sites (c)
	East Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	45.6	6.07	14.3	Lab/other sites (c)
	South Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	103.1	6.07	32.3	Lab/other sites (c)
	Closure Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	188.6	6.07	59.2	Lab/other sites (c)
	1E coarse	LTVSMC coarse	none	3.4	2.68	0.5	Calibration (b)
	1E fine (e)	LTVSMC fine		0.0			
	2E coarse (e)	LTVSMC coarse		0.0			

Source Area	Tailings Basin Sub-area	Tailings Material Assumed to Control Chemical Release	Bentonite Amended	Area (acre)	Percolation (a) (in/yr)	Bottom Seepage (gpm)	Basis for Chemical Release Calculations
	2E fine (e)	LTVSMC fine		0.0			
	2E other	LTVSMC coarse	none	75.3	5.50	21.4	Calibration (b)
	North Buttress banks	Category 1 waste rock	none	45.0	13.27	30.8	Lab / other sites (c)
Pond	Pond	NA	Closure (after 30 years)	972.6	6.50	326.6	Computed (d)
2W	2W coarse	LTVSMC coarse	none	220.1	13.27	150.9	Calibration (b)
	2W fine	LTVSMC fine	none	748.1	15.93	615.7	Calibration (b)
	2W banks	LTVSMC coarse	none	339.2	7.82	137.0	Calibration (b)
	South Buttress banks	Category 1 waste rock	none	15.0	13.24	10.3	Lab/other sites (c)
Total				**3,211.7**		**1,541.8**	

Source: PolyMet 2013f; PolyMet 2013l; and Barr (pers. comm.).

[a] Based on P50 annual rainfall of 27.82 in/yr
[b] Calibrated to water quality of existing affected seepage and groundwater
[c] Laboratory humidity cell tests and water quality at similar mine sites
[d] Pond contaminant concentrations computed during GoldSim simulation
[e] Does not exist in closure

Contaminant Transport from the Tailings Basin

At the Plant Site, most groundwater flow occurs in an unconfined surficial groundwater system composed of unconsolidated sands, silts, and clays, and has a saturated thickness on the order of 7 meters. Below the surficial groundwater system is a low-permeability fractured bedrock unit consisting of several rock types. Groundwater flow rates in the bedrock unit are much less than flow in the overlying surficial groundwater system.

As at the Mine Site, once most of the contaminants are released, they are assumed to travel in the same direction and rate as groundwater (accounting for some dispersion) and ultimately surface water. Groundwater flow rates and flow directions in the model were taken directly from the MODFLOW results or were programmed to be consistent with the MODFLOW results. Unlike the Mine Site, however, PolyMet proposes a containment system along the north and west perimeter of the Tailings Basin to intercept surficial groundwater and surface water seeping from the Tailings Basin. The containment system is assumed to be 90 percent efficient, which means that 10 percent of the approaching groundwater bypasses the system and continues to migrate toward the Embarrass River via the surficial groundwater flowpaths. This affected groundwater migrates in the flowpaths to the north, northwest, and west, and concentrations change progressively at the evaluation locations. With greater transport time, the affected groundwater reaches and discharges directly into the Embarrass River (West Flowpath) or into its tributaries (Northwest and North flowpaths) and can change the river concentrations.

Table 5.2.2-11 provides estimates of contaminant travel times to the evaluation locations and the Embarrass River either directly or via surface tributaries based on best-estimate impact values.

Contaminant arrival would be gradual due to dispersion in the aquifer, and this process is accounted for in the GoldSim algorithms. As shown, travel times at the evaluation locations range from 190 to 240 years, and arrival at the Embarrass River or its tributaries takes about 300 years. These theoretical arrival times apply to all constituents except antimony, arsenic, copper, and nickel, which are attenuated via adsorption as was similarly assumed at the Mine Site. The transport time for these solutes is predicted to be greater than 500 years.

Detailed Descriptions of the Assumptions and Algorithms used to Estimate Solute Release from the Tailings Basin are provided in the Waste Characterization Data Package.

GoldSim Model Operations and Output

Within the GoldSim program are utilities for performing probabilistic simulations based on the uncertainty of inputs. For this method, selected “uncertain” inputs are entered into the program as cumulative probability functions rather than single fixed values. The probability functions are based on the variability of measured data, professional judgment, or both. The types of statistical distributions used for the GoldSim inputs include normal, lognormal, beta, triangular, and uniform. Figure 5.2.2-12 is an example of the cumulative probability function of a hypothetical input. Point A on the figure indicates that there is a 10 percent probability that the true input value is less than or equal to 14.1. Point B (most probable value) indicates a 50 percent probability that the true input is less than or equal to 22.2, and C indicates a 90 percent probability that the true input is less than or equal to 30.3. At the beginning of a model run, GoldSim selects a random probability number between zero and 100 percent for each uncertain input and uses the associated cumulative probability distribution to determine the numerical input value. If for example, the program-selected random probability is 38.6 percent, the input value for the hypothetical input on Figure 5.2.2-12 would be 20.3 (Point D). For some inputs, such as annual rainfall, the random sampling is performed at the beginning of each simulation year as the program progresses through time. With the resulting suite of inputs, a single transient model run is performed (referred to as a “realization”) and the results are saved. The process of statistical sampling is then repeated using new random probabilities and the next realization is run.

The GoldSim model uses a Monte Carlo simulation approach, where the model is run 500 times, with each realization based on unique suite of statistically sampled inputs. At the end of the Monte Carlo simulation, the multiple model run results are compiled. Consider, for example, a model estimate of contaminant concentration at a particular evaluation location at year 100. The GoldSim model will provide 500 numerical values for this result, one for each realization. This suite of resulting values is ordered and used to construct a cumulative frequency plot (Figure 5.2.2-13), which is interpreted in a manner similar to the input plots. On Figure 5.2.2-13 for example, it would be concluded that there is a 90 percent probability that the concentration at year 100 will be less than or equal to 120.8 (Point C). For results that change over time, a convenient way to present the probabilistic results is to prepare a time-series plot showing the 10, 50, and 90 percent probability results, as shown on Figure 5.2.2-14. For example, consider point C on the 90 percent probability line on this plot. At a simulation time of 100 years, the value on the curve is 120.8, indicating a 90 percent probability that the true result will be less than or equal to 120.8, which is consistent with Point C on the 100-year frequency plot shown on Figure 5.2.2-13.

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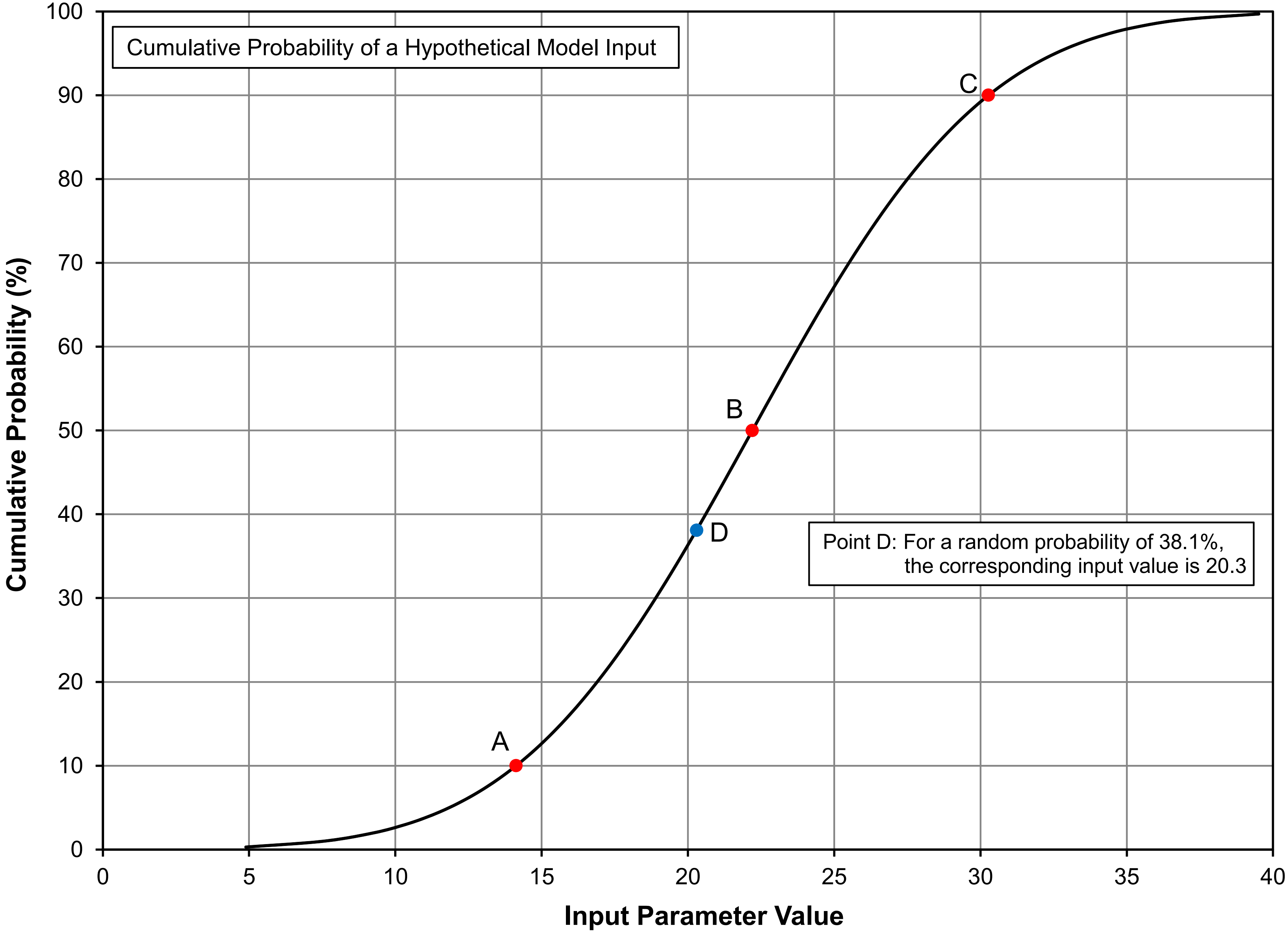

US Army Corps of Engineers
St. Paul District

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Figure 5.2.2-12
Cumulative Probability of a Hypothetical Model Input
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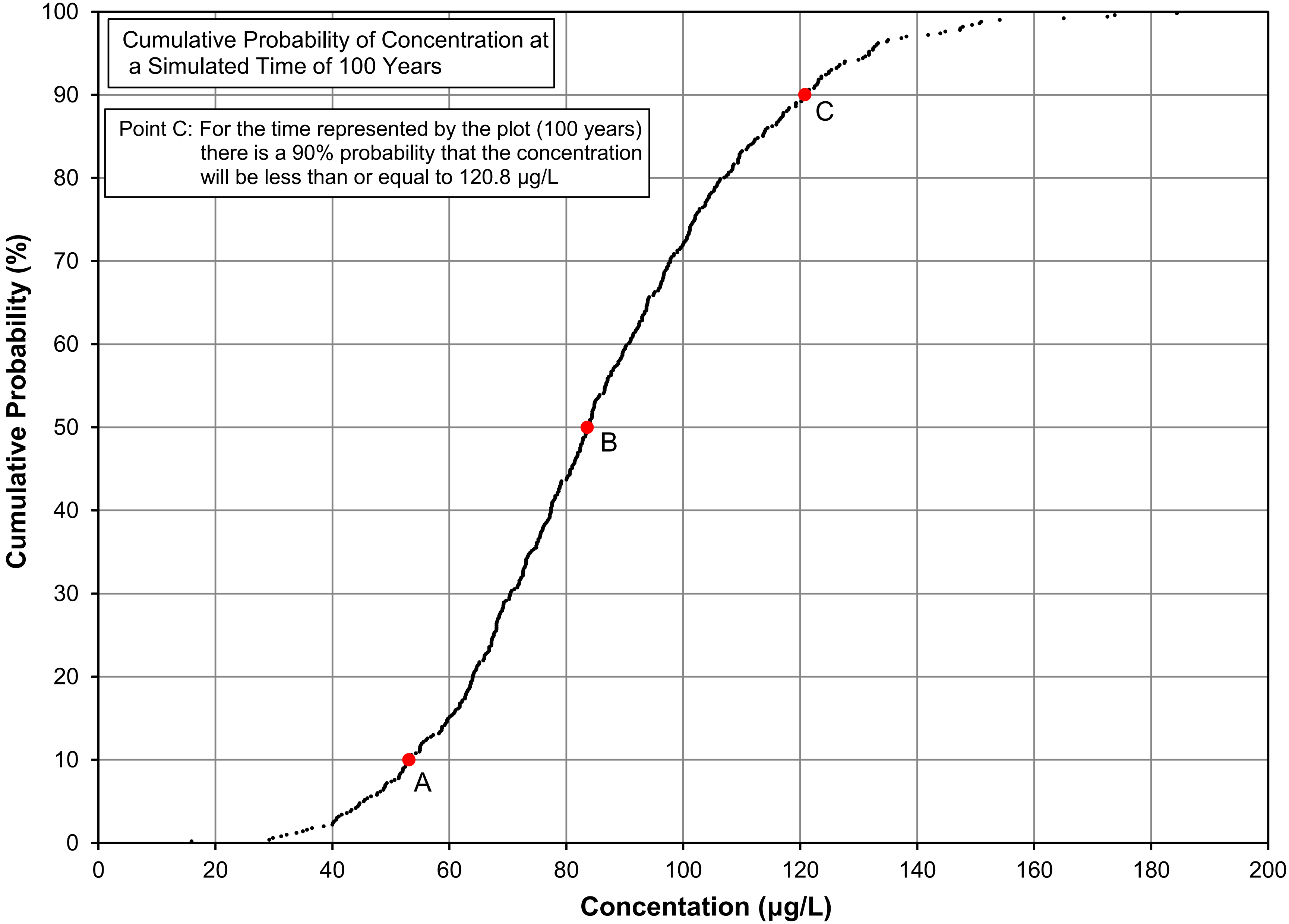

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Figure 5.2.2-13
Cumulative Probability of Concentration at a Simulated Time
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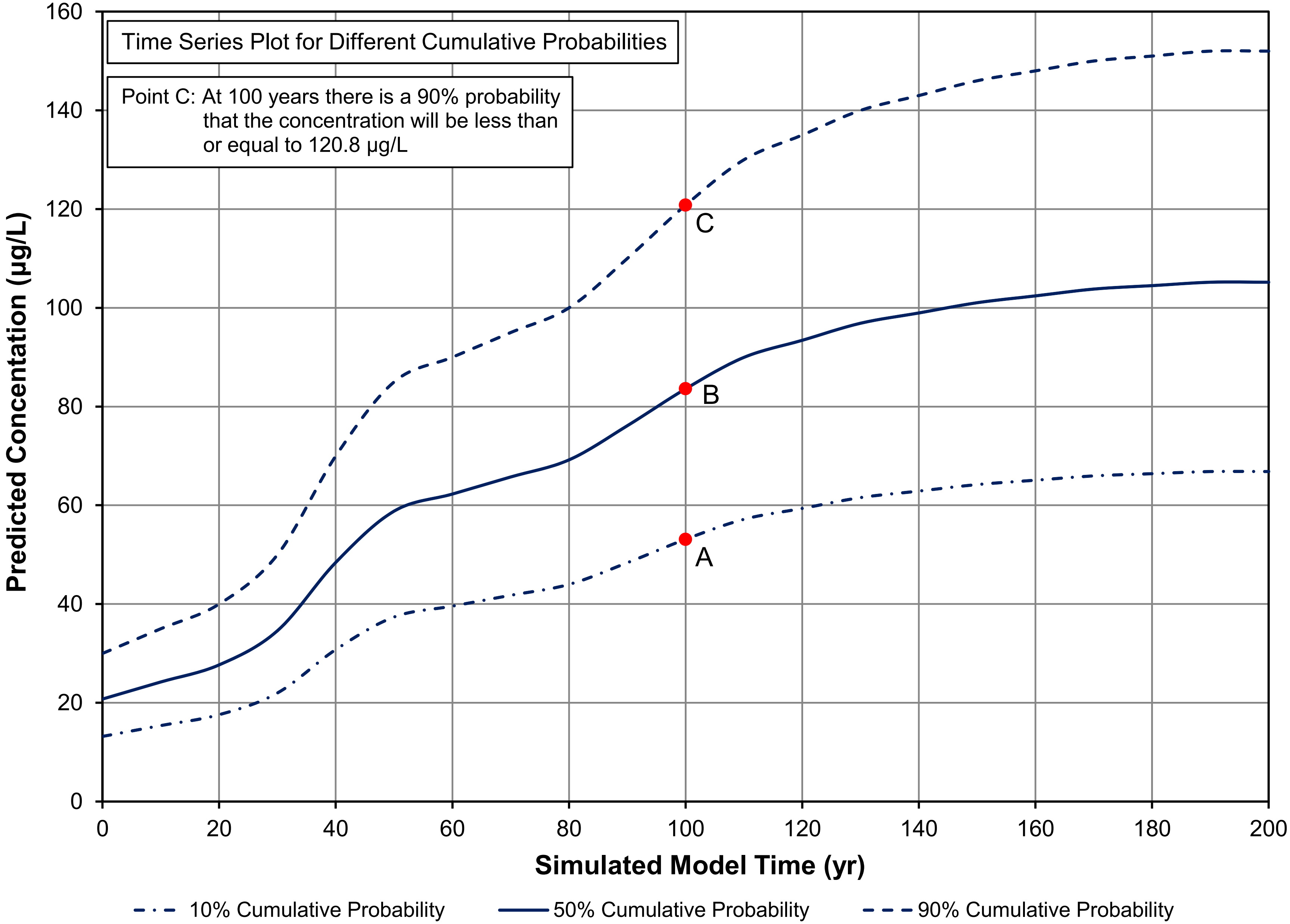

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Figure 5.2.2-14
Time Series Plot for Different Cumulative Probabilities
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This Monte Carlo simulation is run for two alternatives: the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative. The analysis of the model results that follows (Section 5.2.2.3) compares the predicted groundwater and surface water concentrations for the 28 solutes at the 26 evaluation locations (eight groundwater and 18 surface water) over the 200-year model period (actually 2,400 individual monthly time steps—12 months times 200 years) for the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative, and with the evaluation criteria.

5.2.2.3 NorthMet Project Proposed Action

This section discusses the potential environmental consequences of the NorthMet Project Proposed Action on groundwater and surface water levels and quality at both the Mine Site and Plant Site (Tailings Basin) and the Transportation and Utility Corridor.

5.2.2.3.1 NorthMet Project Proposed Action Water Budget Overview

This section briefly describes the water budget under the NorthMet Project Proposed Action at the Mine Site and Plant Site. The NorthMet Project Proposed Action would have to manage water from the following sources:

- stormwater runoff on mine facilities (e.g., waste rock stockpiles, mine pits, tailings storage facility);
- seepage from mine facilities;
- groundwater entering the mine pits;
- process plant makeup water withdrawn from Colby Lake;
- stream augmentation water withdrawn from Colby Lake; and
- discharge from WWTF and WWTP.

An overall water process flow diagram, shown in Figures 5.2.2-7 and 5.2.2-10, shows the principal NorthMet Project Proposed Action components and their relationship to surface water and groundwater resources.

<u>Operations (Year 0 to 20)</u>

Mine Site

During operations (years 0 to 20), water management at the Mine Site would include pit dewatering; the WWTF; stormwater dikes and ditches; and the stockpile liner, cover, and groundwater containment systems. Water from the waste rock stockpiles, Ore Surge Pile, mine pits, and ancillary mine features would be collected at the WWTF, treated, and pumped to the Tailings Basin.

The purpose of the WWTF is to provide water that meets the needs of the NorthMet Project Proposed Action when water is being treated for reuse. During operations, the effluent from the WWTF and runoff from the Overburden Storage and Laydown Area would be pumped via the CPS and the TWP to the Tailings Basin for use as Process Plant makeup water or used to supplement flooding during backfilling of the East Pit. Reuse of the Mine Site process water at the Plant Site would eliminate the need to discharge any process water to surface waters at the Mine Site during operations.

In year 11, after East Pit mining is completed, the pit would be backfilled using Category 2/3 and 4 waste rock from the temporary waste rock stockpiles and from ongoing operations. The East Pit would be flooded with groundwater, in-pit runoff, direct precipitation, and treated process water from the WWTF to 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 pipeline between the WWTF and the East Pit would be left in place during backfilling to manage the water elevation in the East Pit. During periods of high precipitation or during spring snowmelt, dewatering (to the WWTF and ultimately to the Tailings Basin) may be required to allow placement of the waste rock.

Once backfilling of the East Pit is complete in year 21, a mitigation wetland would be constructed over the backfilled material (Figure 5.2.2-15). The water depth in the backfilled East Pit would be maintained within the wetland by a gravity overflow structure to the West Pit.

Plant Site

During operations, the primary source of process water at the Plant Site would be the Tailings Basin, which would contain both water from the flotation process and treated water from the Mine Site. Leakage from the Hydrometallurgical Residue Facility would be collected by the leakage collection component of the double-liner system and returned to the flotation process. Seepage from the Tailings Basin would be collected by the groundwater containment system around the Tailings Basin and returned to the Tailings Basin pond with any excess water discharged via the WWTP.

During operations, the Tailings Basin pond would be the primary collection and distribution point for water used in the beneficiation process. The primary sources of water to the Tailings Basin would include direct precipitation, stormwater run-on, treated process water from the WWTF, and seepage water collected by the Tailings Basin groundwater containment system. The Tailings Basin would collect process water that flows through the Beneficiation Plant and process water pumped from the Mine Site. Direct precipitation and runoff from the process areas at the Plant Site would also be directed to the Tailings Basin.

Containment systems would be installed to collect water seeping from the Tailings Basin and the existing LTVSMC Tailings Basin via surface and surficial groundwater flow. During operations, this water would be returned to the Tailings Basin pond for reuse to the extent possible, with any excess treated at the WWTP and discharged at permitted locations for stream augmentation. The containment system surrounding the north and west sides of the Tailings Basin would consist of a cutoff wall placed into existing surficial deposits, keyed into bedrock, with a collection trench and drain pipe installed on the upgradient side on the cutoff wall. Along the east side of the Tailing Basin, high bedrock eliminates groundwater seepage. Along the south side, geologic features result in all seepage emerging as surface seeps. A cutoff berm with cutoff wall and trench would be placed approximately 200 to 250 ft downstream of the seepage face, coupled with a seep collection sump, a pump and pipe system within the trench that would be used to route this south seepage back into the basin pond or to the WWTP. This loss of flow to Second Creek would be augmented with WWTP effluent at 80 percent of the existing seepage rate (see Section 5.2.2.3.3).

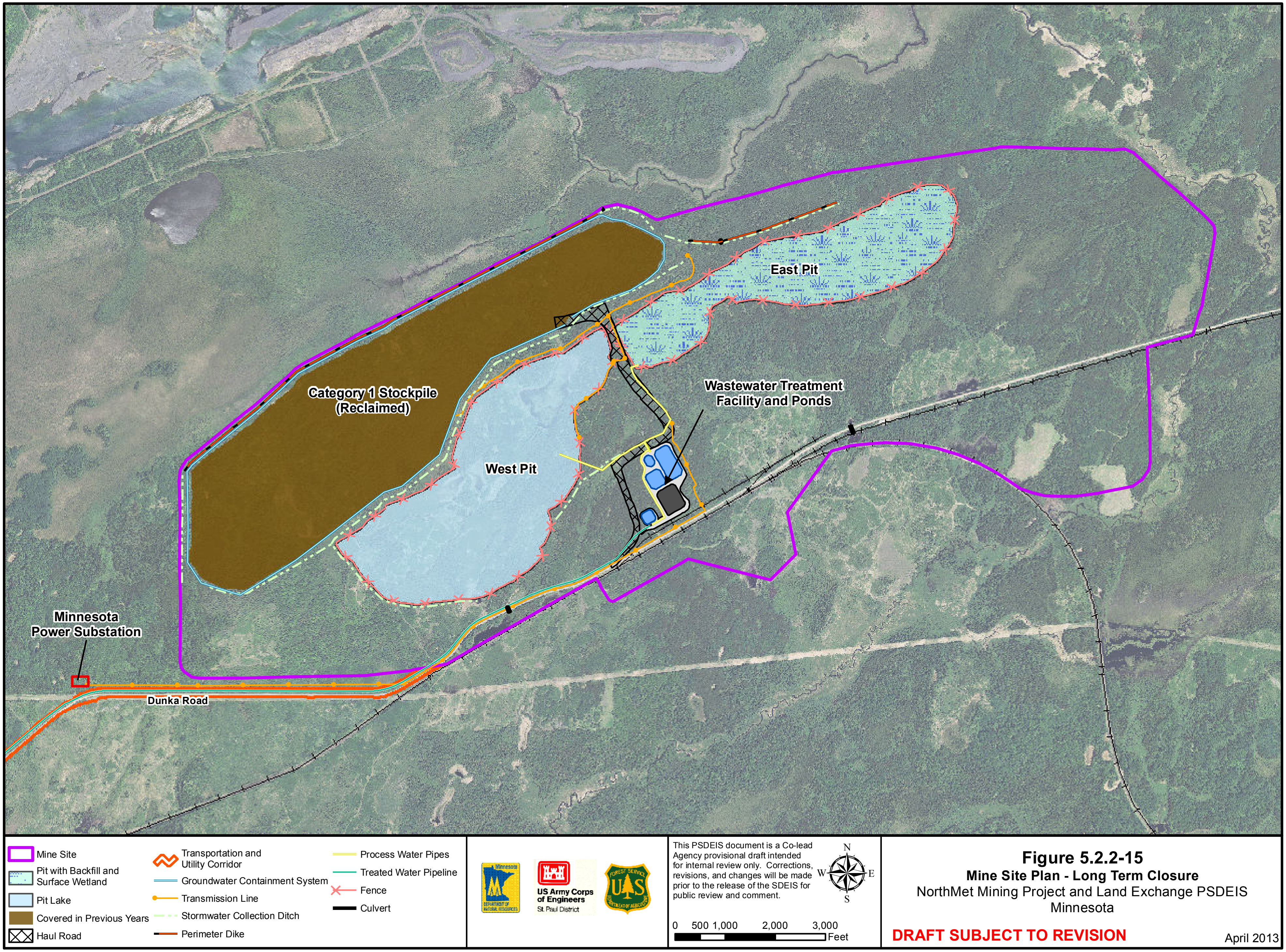

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Figure 5.2.2-15
Mine Site Plan - Long Term Closure
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The purpose of the WWTP is to treat water for discharge to the environment when the NorthMet Project Proposed Action has excess water that cannot be stored in the Tailings Basin. The WWTP would be constructed south of the Tailings Basin near the coarse-crusher and would include an RO unit designed to achieve 10 mg/L sulfate in effluent. Excess WWTP effluent would be discharged to the three Embarrass River tributaries (Unnamed Creek, Trimble Creek, and Mud Lake Creek), as partial fulfillment of required augmentation to maintain downstream hydrology and wetland function (Barr 2013, CDF 069).

Reclamation (Years 20 to 40)

Water management would continue in reclamation and long-term closure. Plant Site reclamation would include building and structure demolition and equipment removal, Tailings Basin reclamation, and Hydrometallurgical Residue Facility reclamation.

During Tailings Basin reclamation, the pond bottom would be covered with a bentonite layer to reduce the downward percolation from the pond, which would reduce the amount of water collected by the Tailings Basin groundwater containment system during reclamation and long-term closure.

Water management would include maintenance of a pond and wetland within the reclaimed Tailings Basin, stormwater management, and continued operation of the WWTP and the groundwater containment system. After reclamation (bentonite amendment of the Tailings Basin beaches and pond bottom and water treatment), the pond would contain clean surface water runoff. A wetland would be constructed on the pond perimeter. The pond and wetland would receive surface water runoff from the crest and beaches of the basin and natural terrain adjacent to the Tailings Basin. The pond and wetland would continue to lose water via seepage, but at a reduced rate as compared to operations as a result of the bentonite amendment of the tailings surface.

The WWTP and the containment systems would continue to operate during reclamation, although seepage rates would be progressively reduced. Seepage would be treated at the WWTP and pumped to the Mine Site (to accelerate West Pit filling) or recycled back into the pond. Most of the WWTP effluent would be used to fill the West Pit during this time, while augmentation water would come exclusively from Colby Lake (Barr 2013e). The WWTP and the containment system would be periodically inspected to ensure continuing integrity.

West Pit reclamation would commence when mining activity ceases. Primary dewatering systems would no longer be operated, and the West Pit would begin to flood naturally with groundwater, precipitation, and surface runoff from the tributary watershed. Flooding would also be accelerated with treated water from the Plant Site WWTP. With the addition of water pumped from the Plant Site to the West Pit, West Pit flooding is projected to be completed in approximately year 40. When the West Pit is full, its discharge would be controlled via a lift station and pumped to the WWTF for treatment. The WWTF would be upgraded to include RO treatment to achieve a 9 mg/L sulfate effluent concentration, which would be discharged into an existing wetland (Figure 5.2.2-15) that flows toward Dunka Road at Outlet Structure OS-5 and eventually into the Partridge River through an existing tributary channel. The reject concentrate from the RO unit would be treated at the WWTF and the filtered sludge would be taken off site for disposal and the effluent would be pumped to the East Pit.

Reclamation of the Hydrometallurgical Residue Facility 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. Once the Hydrometallurgical Residue Facility is reclaimed, the volume of water draining from the drainage collection systems would decline. In the long-term, the volume of water requiring treatment would decline to the point that the remaining reclamation activity may consist of periodic pumping of remaining drainage to the WWTP and of inspection of the reclaimed cell to verify integrity of the reclamation systems.

Closure (After Year 40)

Mine Site

During closure (year 40 and later), water management systems would be modified. Perimeter dikes that would be no longer needed to provide access or separation from the areas outside the Mine Site would be removed (Figure 5.2.2-16). The dike located north of the East Pit would remain in place to minimize mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit in the segments not protected by ditches (Figure 5.2.2-15). In addition, the dike located north of the Category 1 Stockpile would remain in place to allow access to groundwater monitoring locations. The water collected by the Category 1 Stockpile groundwater containment system and the East Pit and West Pit water would be treated using the WWTF to ensure that the discharge meets applicable water quality discharge limits. Water from the East Pit would also be pumped to the WWTF and treated. Reject concentrate from the WWTP would be treated further in the evaporator and crystallizer at the Plant Site and then disposed of off site. WWTF effluent may also be used to manage wetland water levels in the backfilled East Pit (PolyMet 2013g).

Surface runoff would be routed to the mine pits using a combination of existing and new ditches (Figure 5.2.2-15). Some portions of the pit rim dikes may be left in place, if needed to prevent an uncontrolled flow to or from the pits and potential erosion of the pits walls. A more detailed evaluation of this requirement would be conducted prior to mine closure.

Stormwater pond outlet control structures would remain in place as necessary to manage water resource effects. The outlet control structure on the stormwater pond located immediately north of the East Pit and the Category 1 Stockpile would remain in place to minimize the mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit. The outlet control structures on the two stormwater ponds next to Dunka Road would remain in place to direct water under the road and the railroad to a tributary to the Partridge River along natural drainage paths. As a requirement of the NPDES stormwater permit and/or Reclamation 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.

The WWTF would continue to operate during long-term closure, treating excess runoff from the West Pit and discharging the effluent to the small Partridge River tributary. The average discharge flow from the WWTF is 285 gpm. The model includes a higher treatment rate to account for conditions when the freeboard in the pit becomes too small. Discharge during these scenarios is 570 gpm. In the stochastic model, the occasional switch to the “high” treatment flow (1 or 2 months a year, not all years) pushes the long-term average discharge rate above 300 gpm.

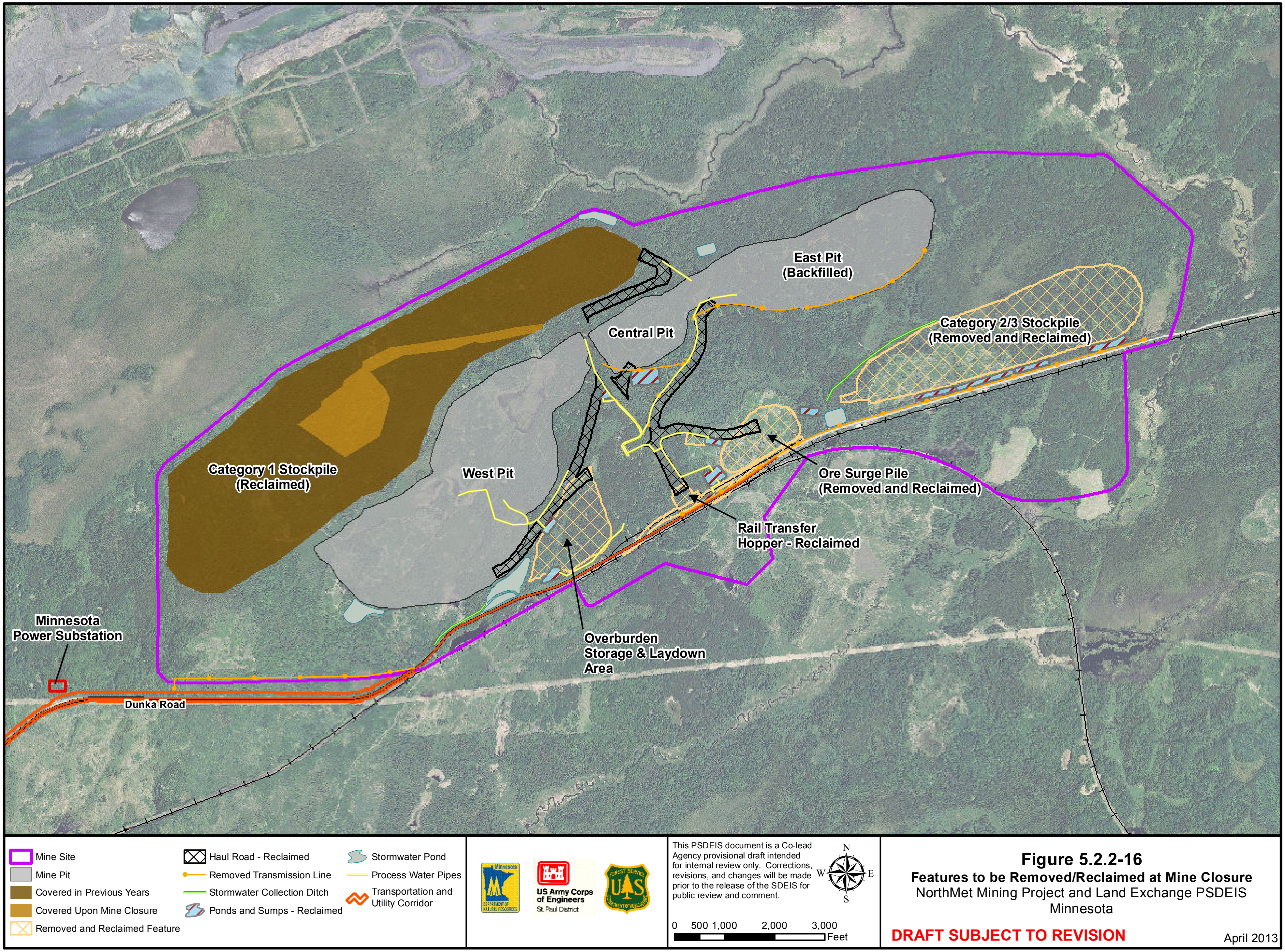

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Figure 5.2.2-16
Features to be Removed/Reclaimed at Mine Closure
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The ultimate objective of long-term closure is to transition from the mechanical treatment provided by the WWTF and WWTP to non-mechanical treatment. Transitions to the non-mechanical treatment systems would begin after the performance of the non-mechanical treatment methods have been proven. At the Mine Site non-mechanical treatment systems are proposed for long-term treatment of water from the Category 1 Stockpile groundwater containment system and the West Pit overflow (see PolyMet 2013g for additional information).

Plant Site

During long-term closure (year 40 and beyond), the WWTP would continue to operate. The WWTP at the Tailings Basin would treat water collected by the Tailings Basin groundwater containment system to meet applicable water quality discharge limits. In addition, most of the WWTP effluent would be used for flow augmentation to Unnamed Creek, Mud Lake Creek, Trimble Creek, and Second Creek. In long-term closure, the flow that would be captured, treated by the WWTP, and discharged would be sufficient to meet the average annual demand of the tributaries, so Colby Lake water would no longer be needed for augmentation (Barr 2013e). The WWTP would be upgraded to include an evaporator to convert the RO reject concentrate to residual solids which would be disposed in appropriate off-site facilities. Inspection, water treatment maintenance, and reporting activities would continue while the mechanical treatment systems operate during long-term closure.

Surface water and groundwater would be monitored as required by relevant permits. These long-term closure activities would be expected to be ongoing until the various facility features are deemed environmentally acceptable, in a self-sustaining and stable condition.

The ultimate objective of long-term closure is to transition from the mechanical treatment provided by the WWTF and WWTP to non-mechanical treatment. Transitions to the non-mechanical treatment systems would begin after the performance of the non-mechanical treatment methods have been proven. Non-mechanical treatment systems are proposed for long-term treatment of water from the Tailings Basin groundwater containment system (PolyMet 2013g).

5.2.2.3.2 Partridge River Watershed

This section discusses the potential environmental consequences of the NorthMet Project Proposed Action on groundwater and surface water hydrology and quality within the Partridge River Watershed, which includes all of the Mine Site, the Transportation and Utility Corridor, and the processing plant. A small portion of the Tailings Storage Facility discharges via a surface seep to the headwaters of Second Creek. This seepage, however, is collected and pumped back to the existing LTVSMC Tailings Basin pursuant to a Consent Decree, and would continue to be pumped back under the NorthMet Project Proposed Action, so is not considered further in this discussion. WWTP effluent would be used to augment flow to Second Creek at 80 percent of the existing seepage rate.

Effects on Groundwater Hydrology

This section discusses the effects of the NorthMet Project Proposed Action on groundwater hydrology, specifically groundwater levels at the Mine Site. The NorthMet Project Proposed Action would not result in any measureable effects on groundwater levels along the

Transportation and Utility Corridor (other than as a result of the West Pit dewatering, which is discussed as part of the Mine Site) or at the processing plant.

The NorthMet Project Proposed Action would affect groundwater levels at the Mine Site during operations by dewatering the active mine pits and pumping water to the Plant Site (years 0 to 11) or to the East Pit and Tailings Basin (years 11 to 20). During years 20 to 40, water from the Plant Site would be pumped to the West Pit to accelerate flooding and help return groundwater levels to near pre-mining conditions.

Inflow to Mine Pits

The expected rate of groundwater inflow to the East Pit and West Pit during operations was estimated from MODFLOW modeling, similar to that performed for the DEIS. The model was updated in several ways, including the following:

- MODFLOW model was re-calibrated using target baseflows of 0.41 cfs at SW-002, 0.51 cfs at SW-003, and 0.92 cfs at SW-004 to reflect revisions from the XP-SWMM model; and
- Groundwater elevations at monitoring wells MW-1 through MW-18 were included as targets in the updated calibration.

These updated estimates of groundwater inflow rates to the pits were used to develop the overall water balance for the probabilistic model. Table 5.2.2-17 shows the MODFLOW predicted inflows to the pit (years 1 to 20) as well as outflows during closure once the pits have flooded.

Table 5.2.2-17 Groundwater Inflows and Outflows at the Mine Pits Based on MODFLOW Results

	West Pit		Central Pit		East Pit	
Year	**Inflow Gpm**	**Outflow gpm**	**Inflow gpm**	**Outflow gpm**	**Inflow gpm**	**Outflow gpm**
1	0	0	0	0	80	0
2	50	0	0	0	70	0
3	40	0	0	0	80	0
4	30	0	0	0	90	0
5	30	0	0	0	150	0
6	40	0	0	0	140	0
7	40	0	0	0	140	0
8	40	0	0	0	160	0
9	30	0	0	0	230	0
10	30	0	0	0	240	0
11	100	0	20	0	320	0
12	70	0	10	0	280	0
13	60	0	10	0	240	0
14	50	0	10	0	240	0
15	50	0	10	0	240	0
16	50	0	10	0	200	0
17	50	0	10	0	140	0
18	40	0	10	0	100	0
19	40	0	10	0	60	0
20	50	0	10	0	10	0

	West Pit (a)		Combined Central and East Pits (b)	
Long-term Closure	Inflow gpm	Outflow gpm	Inflow gpm	Outflow gpm
	40	<10	30	<10

[a] Open pit lake with water-surface elevation at approximately 1,576 ft amsl.
[b] Combine pits backfilled and resaturated with water-level elevation at approximately 1,592 ft amsl.

Extent of Pit Drawdown

Understanding the extent of groundwater drawdown, especially in the surficial material surrounding the NorthMet Project Proposed Action mine pits, is important in order to assess the potential effects on nearby surface water features such as wetlands. However, the complex mix of fractured bedrock, glacial till, and wetland soils at the Mine Site makes it difficult to accurately quantify drawdown at any specific location. Site characterization data and MODFLOW calibration results indicate that the bulk hydraulic conductivity of bedrock is much lower than the bulk hydraulic conductivity of surficial materials. As a consequence, the bedrock tends to be saturated and overlain by a thin surficial aquifer that dominates the local groundwater flow system. In a dewatering situation, the lower-permeability bedrock will tend to remain saturated because it is subject to leakage from the overlying higher-permeability surficial aquifer.

Water table drawdown in the surficial aquifer near the mine pits would be limited because it would be subject to meteoric recharge and has a saturated thickness on the order of only 14 ft.

These wide ranges in hydraulic conductivity within the natural geologic formations at the Mine Site, especially within the glacial till, are not unusual. Monitoring well response to pit dewatering at the Canisteo Pit, located approximately 65 miles west of the NorthMet Project in similar surficial geology, indicated extreme aquifer heterogeneity. Modeling of aquifer response at the Canisteo site using MODFLOW resulted in differences between simulated and measured water levels ranging from +28 ft to -4 ft (reference USGS Report 02-4198). The model clearly could not accurately estimate water level changes of a few feet or less as would be desirable for assessing potential effects on nearby surface water features such as wetlands. Therefore, it was concluded that it was not reasonable to attempt to quantify drawdown at the Mine Site using the MODFLOW model.

In lieu of using MODFLOW to estimate pit drawdown at the Mine Site, an analog approach was developed using available well data from the Canisteo Pit, which is the only mine pit within the Mesabi Iron Range that has an associated water balance study with well data that could be used to assess potential drawdown effects. Sixteen Canisteo wells were used for the analog evaluation; an additional shallow well near Kinney, Minnesota, adjacent to Minntac's West Pit, and one deep bedrock well, also near Kinney, were also used for the evaluation. A comparison of the hydrogeologic conditions at the Canisteo Mine Pit, the Kinney area wells, and the Mine Site concluded that the geologic and hydrogeologic settings of the Mine Site are relatively similar to the Canisteo and Minntac sites (Barr 2011h).

One significant difference between the Canisteo site and the Mine Site is that the glacial till at the Canisteo site ranges from 50 to 100 ft thick, while till at the Mine Site averages only 14 ft thick. Also, the underlying bedrock at the Canisteo site is composed exclusively of the Biwabik Iron Formation, which generally has a higher hydraulic conductivity than the Duluth Complex and Virginia Formation which underlies the glacial till at the Mine Site. These two differences are believed to result in a greater potential for drawdown at the Canisteo site than at the Mine Site. Overall, the Canisteo data are believed to provide a reasonably conservative estimate of the maximum extent of surficial groundwater drawdown resulting from the PolyMet mine pits.

Several years of well water level data were used to measure response to the changing Canisteo Pit water level, and response to the approaching, dewatered Minntac West Pit (ERM and MDNR 2011).

The following were conclusions of the analog study:

- three wells within 700 ft of the Canisteo Pit showed a strong response to the rising pit water;
- six wells within 900 to 2,625 ft from the pit showed a measurable, but weak, response to the rising pit water;
- seven wells within 660 to 3,500 ft showed no response to the rising water;
- the deep bedrock well near Kinney started to show an apparent, progressive water level drop when the dewatered Minntac West Pit approached within about 1,000 ft of the well; and
- the shallow well near Kinney did not show any measurable water level drop from June 2000 through March 2003 (when data collection stopped for safety reasons), during which time the dewatered Minntac West Pit had advanced to within 900 ft of the well.

As can be seen by the above conclusions, an important finding of the analog evaluation was that there was no clear, systematic relationship between the proximity of wells to mine pits and effects on water levels.

Given the analog evaluation conclusions, the following guidelines for potentially measurable drawdown were developed at the Mine Site:

- 0 to 1,000 ft from the pit rim: groundwater drawdown from pit dewatering may occur and may be measurable;
- 1,000 to 1,700 ft from the pit rim: groundwater drawdown from pit dewatering may occur, but may be difficult to distinguish from natural variations in background water levels;
- 1,700 to 3,200-plus ft from the pit rim: groundwater drawdown from pit dewatering may occur, but would likely only occur under certain hydrogeologic conditions, and may not be discernible from natural variability; and
- beyond 3,200 ft from the pit: no effects expected.

These guidelines are intended to help define zones of potential groundwater drawdown that can be used to estimate potential indirect effects on nearby surface water features and wetlands (see Section 5.2.3 for further discussion of this analog approach). They can also be used to design a monitoring program to quantify actual effects, which can trigger appropriate mitigation measures if warranted. Contingency mitigation options are discussed in the Water Management Plan for the Mine Site (PolyMet 2013i). These guidelines have been expanded considerably since the original analog study (see Section 5.2.3).

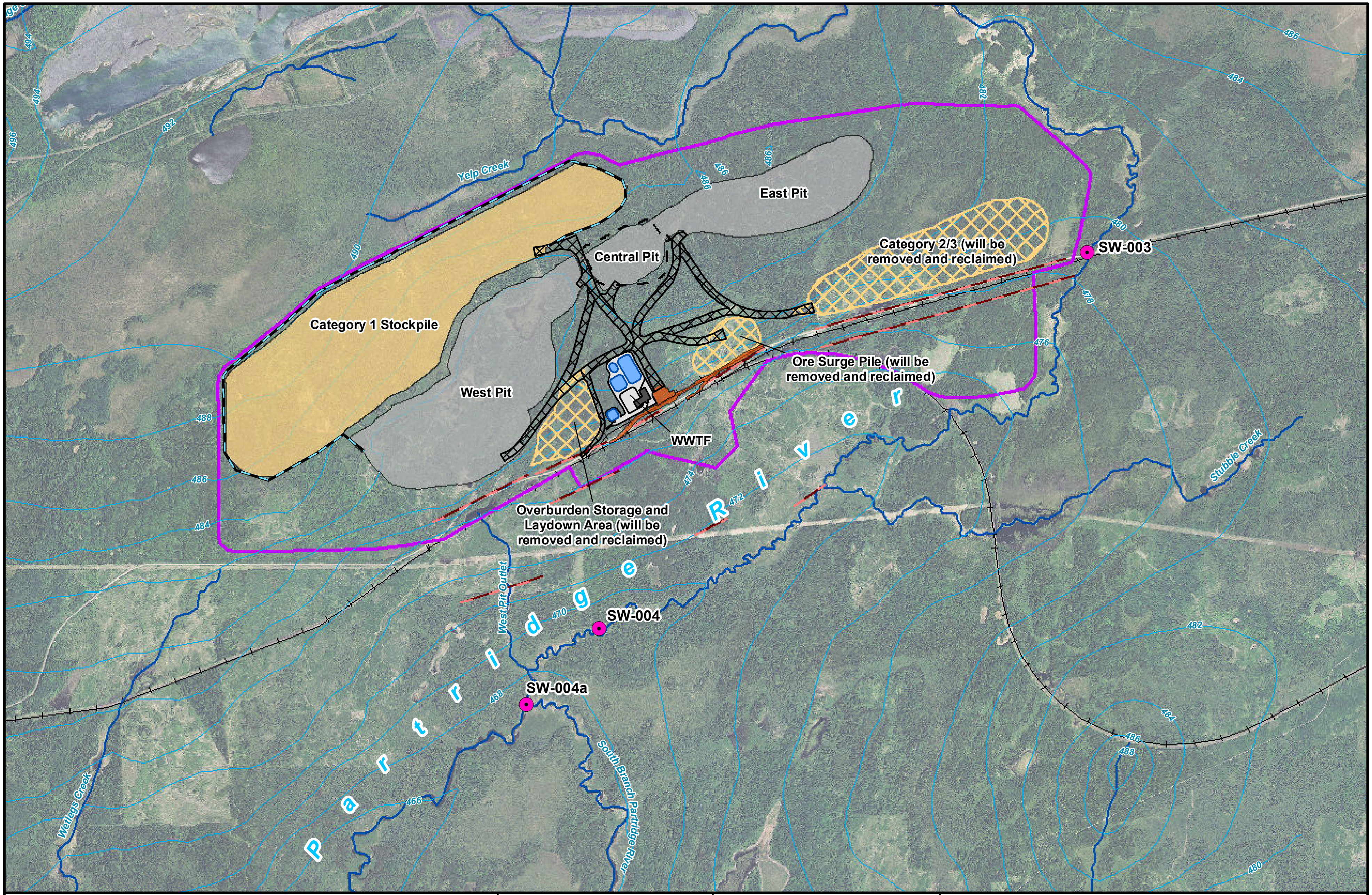
Note that these guidelines would apply during mine operations and reclamation, but groundwater drawdown associated with the mine pits should decline and essentially cease as the pits flood. The actual steady-state water levels in the pits would be established by outlet structures that would be used to route surface overflows from the East Pit (invert at elevation 1,592 ft amsl) into the West Pit, and from the West Pit (invert at elevation 1,581 ft amsl). 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. A permanent drawdown of a maximum of about 20 ft immediately surrounding the West Pit lake resulting from a closure groundwater elevation of 1,581 ft versus existing groundwater elevation of approximately 1,600 ft, and about 10 ft immediately surrounding the East Pit resulting from a closure groundwater elevation of 1,592 ft versus existing groundwater elevation of approximately 1,600 ft.

Effects on Groundwater Quality in the Surficial Aquifer

The NorthMet Project Proposed Action could affect groundwater quality at the Mine Site by leaching metals, sulfate, and other solutes from exposed waste rock, overburden, and ore. Groundwater would serve as the primary pathway for transporting contaminants leached from mine facilities to the Partridge River.

Potential Sources of Groundwater Contamination and Proposed Engineered Controls

The potential sources of groundwater contamination from the NorthMet Project Proposed Action within the Partridge River Watershed include the waste rock stockpiles, the Overburden Storage and Laydown Area, the Ore Surge Pile, the WWTF, and the mine pits (Figure 5.2.2-17). Each of these sources is briefly described below and key features are summarized in Table 5.2.2-18. Note that the Category 2/3 Stockpile, the Overburden Storage and Laydown Area, the Ore Surge Pile, and the WWTF equalization ponds, which are the source of affected groundwater at this facility, would only exist during mine operations and would cease being a source after approximately year 20. Most seepage from the Category 1 waste rock facility would be captured during operations, and any seepage not captured during or after operations would enter the West Pit, so the long-term effect of the Category 1 waste rock facility is considered as part of the West Pit water. The mine pits and Category 1 stockpile would be the only facilities that would remain with the potential to behave as long-term sources of contamination. It is assumed that any uncollected seepage from the Category 4 Stockpile liner system would follow the hydraulic gradient to the East Pit, where it would be collected as part of the pit dewatering system and pumped to the WWTF for treatment.



Groundwater Evaluation Locations
Surficial Aquifer Head Contour (m) at Closure
Groundwater Containment System
Surface Water Modeling/Monitoring Location
Stream/River
Mine Site
Haul Road
Mine Pit
Permanent Stockpile
Removed and Reclaimed Stockpile
Removed Stockpile

US Army Corps of Engineers
St. Paul District

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

0 1,000 2,000 4,000 Feet

Figure 5.2.2-17
Mine Site Contaminant Source Areas
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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April 2013

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Table 5.2.2-18 Mine Site Chemical Source Areas used in GoldSim

Source Area	Active Source Period (mine years)	Engineered Features	Chemical Mechanisms
Category 1 Stockpile	0+	Geomembrane cover; perimeter groundwater containment system.	Chemical constituents released from Category 1 Stockpile material at concentration caps. Water in containment system sent to the WWTF or the West Pit.
Category 2/3 Stockpile	0-20	Geomembrane liner with seepage collection.	Oxidation of Category 2/3 Stockpile material. Seepage through liner would enter the underlying groundwater system.
West Pit	Pit lake: 20+ Flow to groundwater flowpaths: 33+[1]	Dewatered during mining; refill at year 33. After refill, the pit lake water level would be controlled by pumping to the WWTF.	Oxidation of wall rock prior to refill. Receives affected water from East Pit. Receives treated (or blended) water from Plant Site WWTP during refill period (20-33 years). Receives treated water from Mine Site WWTF. After refill, pit lake water would enter the surficial groundwater flow system (beginning in year 33).
East Pit	Flow to groundwater flowpath: 21+[1] Flow to West Pit: 22+[1]	Would merge with the Central Pit. Dewatered during mining; backfilled with Category 2/3Stockpile material; backfill completely saturated after year 21.	Oxidation of wall rock prior to backfill saturation. Chemical release from unsaturated and saturated backfill. Water in saturated backfill would overflow to West Pit beginning year 22 and enter surficial groundwater flow system beginning in year 21.
Overburden Storage and Laydown Area	0-35	Unlined facility, but with collection system for surface runoff.	Leaching of overburden materials. Seepage would enter surficial groundwater flow system.
WWTF Basins	0-22	Precipitation treatment plant using equalization basins with geomembrane liners.	Receives water from West Pit (including East Pit overflow), Category 1 Stockpile, Category 2/3 Stockpile, Overburden Storage and Laydown Area, and Ore Surge Pile. Receives RO concentrate from Plant Site WWTP. Seepage through liners would enter surficial groundwater system up to year 35.
Ore Surge Pile	0-21	Geomembrane liner with seepage collection.	Oxidation of ore. Seepage through liner would enter surficial groundwater system.

Source: PolyMet 2013g.

[1] Based on deterministic GoldSim run with P50 inputs.

All of these potential chemical sources would be located at the Mine Site. The only potential chemical sources along the Transportation and Utility Corridor or at the processing plant (both within the Partridge River Watershed) would be from spills, as there would be no surface stockpiles of waste rock, ore, or other potential chemical sources in these areas.

No effects on groundwater quality along the Transportation and Utility Corridor are anticipated during construction or closure as part of the NorthMet Project Proposed Action. There is the potential, however, for ore spillage from rail cars during transport from the Mine Site to the processing plant. It is estimated that 55.7 kg ore/m^2 track could spill from rail cars within the first 1,000 meters of the Transportation and Utility Corridor over the 20-year life of the NorthMet Project Proposed Action. This is equivalent to 1.25 inches of spilled material over a 2,000 m^2 area. Rainfall contacting the spilled ore material has the potential to release chemicals, but the small volume of ore and dilution from other sources, water quality is expected to meet the evaluation criteria (PolyMet 2013l).

During closure, there may be residual effects on groundwater quality from the spilled ore, although the small quantity of expected spilled material would become depleted of sulfide materials rapidly compared to the much larger waste rock stockpiles (PolyMet 2013l).

In order to guard against possible adverse effects from spilled ore, monitoring and mitigation activities would be developed. Water quality monitoring is recommended downgradient from the rail line on the tributary streams to check for any deteriorations of water quality over time from ore spillage, and, if detected, adaptive water management measures would be implemented.

Waste Rock Stockpiles

The NorthMet Project Proposed Action would generate about 308 million tons of waste rock over the 20 years of mine operations. This waste rock would be managed according to its geochemical properties. Four categories of waste rock were defined generally based on its sulfur content as summarized in Table 5.2.2-19.

Table 5.2.2-19 Summary of Waste Rock Properties

Waste Rock Categorization	Sulfur Content (%S)[1]	Approximate % of Waste Rock Mass	Max Footprint (acres)	Stockpile Duration	Liner System	Cover System
Category 1	%S ≤ 0.12	70%	526	Permanent	No liner system; a groundwater containment system would collect water for pumping to the WWTF.	3-ft engineered geomembrane cover.
Category 2	0.12 < %S ≤ 0.31	24%	180[3]	Temporary	12-inch compacted (1x10-5 cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer.	Stockpile to be completely removed and reclaimed.
Category 3	0.31 < %S ≤ 0.6	3%	180[3]	Temporary	12-inch compacted (1x10-5 cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer.	Stockpile to be completely removed and reclaimed.
Category 4[(2)]	0.6 < %S	3%	57	Temporary	12-inch compacted (1x10-6 cm/s) subgrade overlaid by 80 mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer.	Stockpile to be completely removed and reclaimed.

Source: PolyMet 2013c.

1 In general, the higher the rock's sulfur content, the higher its potential for generating acid rock drainage or leaching heavy metals.
2 Includes all Virginia formation rock.
3 Max footprint is total for Category 2/3 waste rock.

As Table 5.2.2-19 above indicates, the Category 1 Stockpile would be permanent. It would not have a liner, but would be surrounded by a groundwater containment system consisting of a cutoff wall (i.e., low-permeability hydraulic barrier) and a subsurface drain that would collect nearly all (approximately 93 percent) of the seepage from the stockpile. This stockpile would be progressively reclaimed with an engineered geomembrane cover system constructed from year 14 through 21. About 7 percent of the seepage is estimated to bypass the containment system, but would flow as groundwater to the West Pit where it would be collected and pumped to the WWTF for treatment.

The Category 2/3 Stockpile and Category 4 Stockpile would be temporary, and therefore would not require a cover. Each of these stockpiles, however, would be constructed with a liner system including a compacted subgrade, an underdrain, an impermeable geomembrane liner, an overliner drainage layer, and a drainage/leachage collection system. Drainage from these stockpiles would be collected on the liner and routed to a lined sump for pumping to the WWTF for treatment. Once mining of the East Pit is completed (approximately year 11), the Category 2/3 and Category 4 waste rock would be backfilled into the East Pit, the liner system would be removed, and the footprints of these stockpiles reclaimed.

The GoldSim modeling assumes, however, that some leachate seeps through tears/flaws in the Category 2/3 Stockpile geomembrane liner, reaches the groundwater table, and follows what is referred to as the Category 2/3 Stockpile and East Pit Flowpath ultimately discharging to the Partridge River. Some leachate from the Category 4 Stockpile is also assumed to seep through the liner system, but given its location adjacent to the East Pit, it is assumed that any uncollected seepage would follow the hydraulic gradient to the East Pit, where it would be collected as part of the pit dewatering system and pumped to the WWTF for treatment.

Overburden and Overburden Storage and Laydown Area

The NorthMet Project Proposed Action would strip overburden as needed for mine development, thereby minimizing the amount of exposed bedrock at any one time. About 32 percent of the overburden would be stripped in the first 2 years of the mine life, with the balance being removed by the end of year 11. Overburden present at the Mine Site is categorized into three types: unsaturated overburden, saturated overburden, and peat (organic soils). Each type of overburden would be managed in accordance with its characteristics.

Saturated overburden is the material that has been below the normal water table and not exposed regularly to oxygen, so it is still potentially reactive. Some of this material would be used for construction purposes, but only for applications where it would be placed below the water table or where any water contacting it would be collected and appropriately treated. Saturated overburden not used for construction purposes would be commingled with waste rock and placed in the temporary Category 2/3 Stockpile with a geomembrane liner.

Unsaturated overburden is above the normal water table, and waste characterization studies indicate that it has been exposed to oxygen for a sufficiently long period of time that it is now non-reactive. This material would be used for construction purposes. To the extent that unsaturated overburden exceeds immediate construction needs, it would be temporarily stored in the unlined Overburden Storage and Laydown Area. Peat would also be used for construction purposes as appropriate, and any excess would be temporarily stored along with the unsaturated overburden in the unlined Overburden Storage and Laydown Area for future use during reclamation. Surface runoff from the Overburden Storage and Laydown Area is considered "Process Water," and would be captured in an unlined pond (Pond PW-OSLA) and monitored for quality. If the Overburden Storage and Laydown Area water were of high enough quality, it would be pumped to the CPS and discharged to the East Pit or the Tailings Basin, where the destination would be based on variable project demand over time. If water in Pond PW-OSLA required treatment, it would be pumped to the WWTF for treatment prior to delivery to the CPS.

Since the Overburden Storage and Laydown Area would be unlined, the GoldSim model assumes meteoric water would seep into the groundwater below the Overburden Storage and Laydown Area and follow what is referred to as the Overburden Storage and Laydown Area Flowpath ultimately discharging to the Partridge River. The water quality of this seepage was estimated based on the results of the Meteoric Water Mobility Procedures test for peat and unsaturated overburden (PolyMet 2013l).

Ore Surge Pile

An Ore Surge Pile would be constructed near the rail transfer hopper to allow for temporary storage of ore and a steady flow and uniform grade of ore to the processing plant. Ore would flow into and out of this pile during the life of the mine as needed to meet plant operations. The Ore Surge Pile would have a liner system identical in design to that for the Category 4 Stockpile. Drainage from the Ore Surge Pile would be collected on the liner and routed to a lined sump for pumping to the WWTF for treatment. The Ore Surge Pile, including the liner system, would be removed at the completion of mining activities and reclaimed.

The GoldSim modeling assumes, however, that a small volume of leachate seeps through tears/flaws in the geomembrane liner, reaches the groundwater table, and follows what is referred to as the Ore Surge Pile Flowpath ultimately discharging to the Partridge River.

East Pit

During mining, the pits would be dewatered. In year 11, mining of the East Pit would be completed and the East Pit would begin to flood, augmented by the backfilling of the Category 2/3 and Category 4 waste rock. The backfilling of the waste rock into the East Pit initially results in a sharp peak in solute concentrations (see Figure 5.2.2-18 for a representative example using sulfate), but once submerged, oxygen transport drops to near zero, so the oxidation and associated dissolution of sulfide minerals essentially stops. The water in the West Pit would have dissolved oxygen in the water. The amount would be dependent upon a number of things, but would perhaps be as high as 10 mg/L. This would be reactive with the pit wall/waste rock. The reactivity would decrease rapidly over time. There is very little hydraulic gradient so the only mechanism for oxygen to reach unoxidized rock beyond the surface would be through diffusion. This, in combination with the cycling of pit water through the WWTF, results in a dramatic decrease in solute concentrations by year 20 (again see Figure 5.2.2-18 as a representative example).

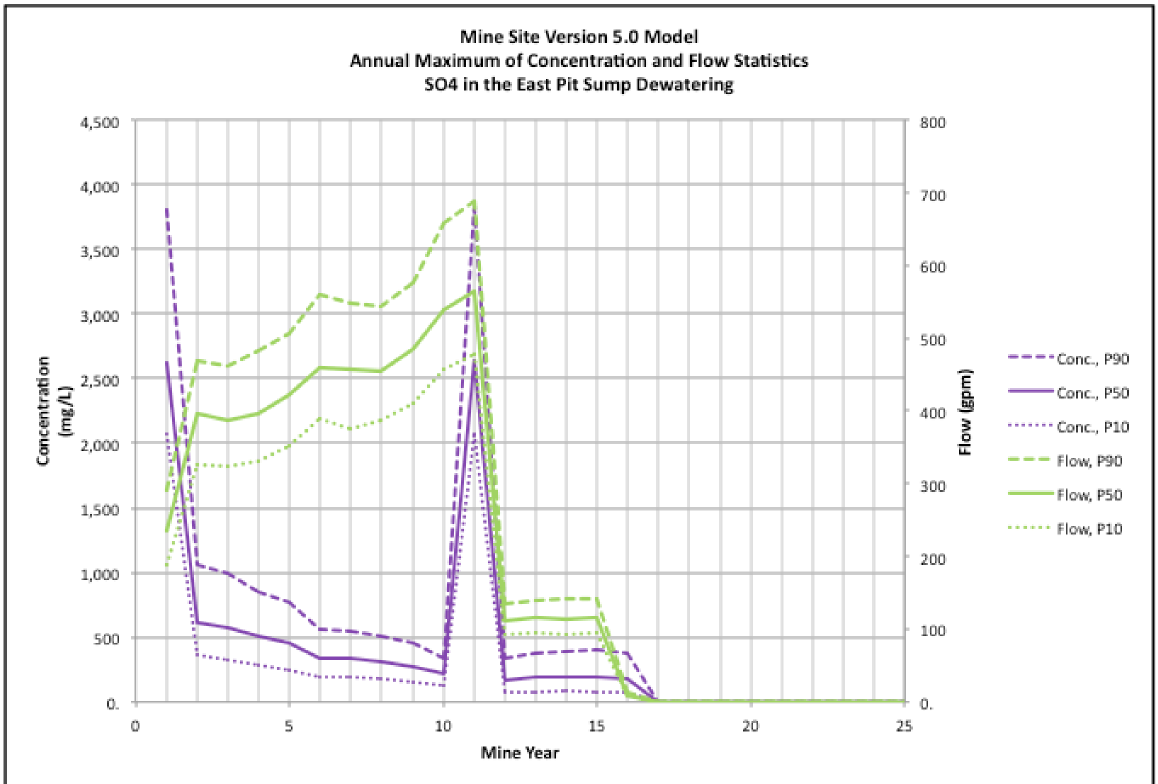


Figure 5.2.2-18 Annual Average SO_4 Concentration East Pit Pore Water (Flow to Wastewater Treatment Facility)

Once the water in the flooded pit reached the top of bedrock along the pit rim (approximate elevation of 1,577 ft), some water would begin to flow from the pit into the surficial aquifer. The quality of this groundwater outflow would reflect the quality of the pit water over time. This groundwater outflow would follow what is referred to as the Category 2/3 Stockpile and East Pit Flowpath, ultimately discharging to the Partridge River.

Since both the Category 2/3 Stockpile and the East Pit share the same flowpath, this flowpath produces two concentration peaks, the first representing the arrival of solutes from the Category 2/3 Stockpile, which would reach the Partridge River around year 30 and would peak around year 58, and the second from the arrival of seepage from the East Pit, which would reach the Partridge River around year 80 and would peak around year 150 (Figure 5.2.2-19).

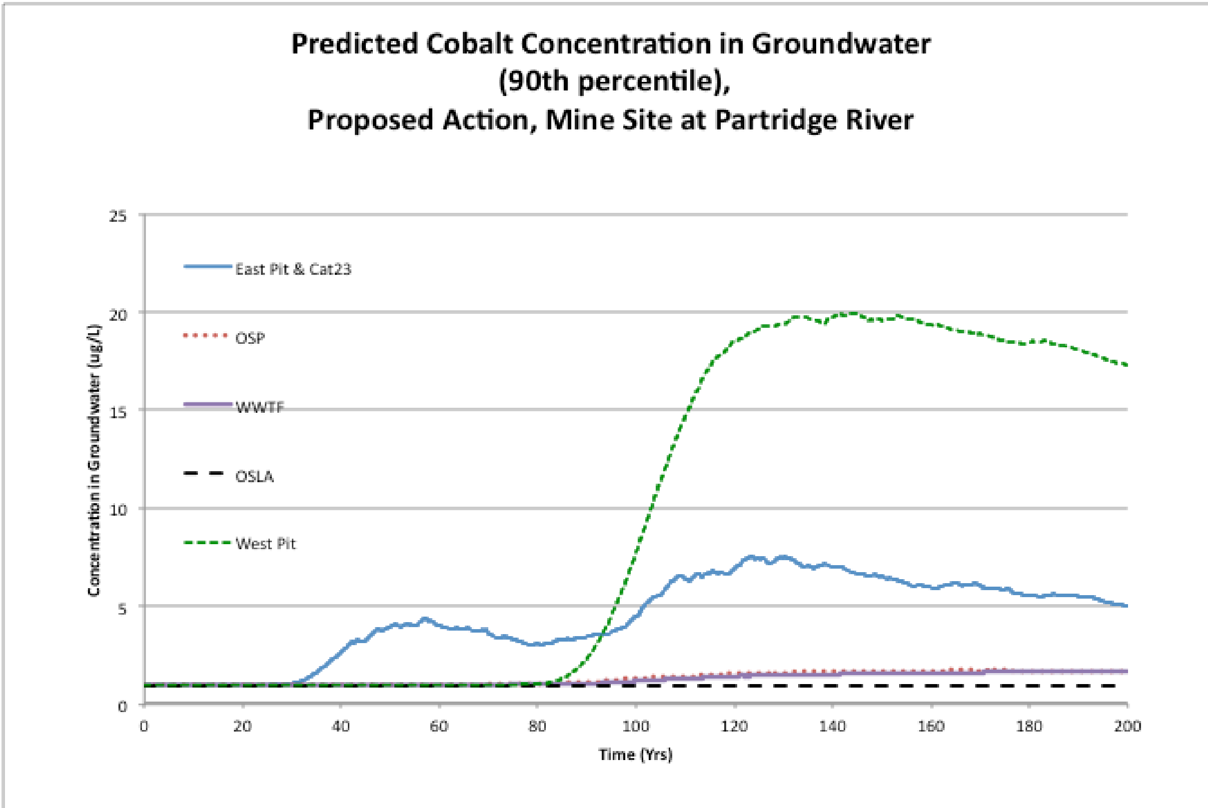


Figure 5.2.2-19 Predicted Maximum P90 Concentration of Cobalt in Groundwater at the Partridge River

West Pit

Flooding of the West Pit would begin in year 20 when mining would be completed. Once the water in the flooded pit reaches the top of bedrock along the pit rim (approximate elevation 1,550 ft and year 35), some water would begin to flow from the pit into the surficial aquifer. The quality of this groundwater outflow would reflect the quality of the pit water over time, although it should be noted that during closure, water in the West Pit would be treated at the WWTF. The groundwater outflow would follow what is referred to as the West Pit Flowpath ultimately discharging to the Partridge River.

Wastewater Treatment Facility

The WWTF would treat influent water from a variety of sources (e.g., pit dewatering, stockpile leachate collection, contact surface water). The only potential source of groundwater contamination at the WWTF would be influent leaking from the two equalization basins and effluent leaking from the CPS. These basins would also have a geomembrane liner system. Leakage from these basins through the liner system is calculated differently than for the waste rock stockpile liner systems in that these systems are intended to store water and do not have positive drainage. Therefore, the hydraulic pressure on the liners would be greater, and, in turn, more water would be expected to leak on a per acre basis (i.e., approximately 5 gallons per acre per day) (PolyMet 2013i). The total volume of leakage from the equalization basins, however, would be less than from the stockpiles as the footprint of the equalization basins would be much less. This leakage would reach the groundwater table and follow what is referred to as the WWTF Flowpath ultimately to the Partridge River.

Groundwater Transport and Evaluation Locations

Chemicals from each source area described above would be transported by groundwater along its associated flowpath (Figure 5.2.2-4). Each of these flowpaths has an evaluation location where the GoldSim model predicts groundwater quality, either the PolyMet property boundary or the Partridge River, whichever is closer to the source area (Figure 5-2.2-4). At each evaluation location, the predicted water quality for the NorthMet Project Proposed Action is compared with both the evaluation criteria and the predicted water quality for the NorthMet Project No Action Alternative.

The time at which contaminants leached from the Mine Site begin to affect water quality at the downgradient evaluation points depend on the following four variables:

- the time (i.e., year) when the source facility is constructed or begins leaching contaminants;
- the rate at which contaminants move in groundwater (assumed to equal the groundwater flow rate for all constituents except the four attenuated contaminants - arsenic, antimony, copper, and nickel - which are assumed to migrate more slowly than the groundwater);
- the distance between the source and the evaluation point; and
- mechanical dispersion, which tends to spread out the chemical plume.

The estimated migration times for contaminant plumes to reach the evaluation locations are presented in Table 5.2.2-20.

Table 5.2.2-20 Chemical Migration Times for Mine Site Groundwater Flowpaths

	Chemical Source Times		Chemical Migration Times to Property Boundary[1]		Chemical Migration Times to SW Discharge or River[1]	
Surficial Groundwater Flowpath	**Start Mine Year**	**Stop Mine Year**	**Initial Concentration Increase Mine Year**	**Peak Concentration Mine Year**	**Initial Concentration Increase Mine Year**	**Peak Concentration Mine Year**
Mine Site – Category 2/3 Stockpile	0	20	12	30	30	55
Mine Site – East Pit	21[4]	Continuous	90	130	110	155
Mine Site – Ore Surge Pile	0	21	90	165	90	165
Mine Site – WWTF	0	35	75	150	95	175
Mine Site – Overburden Storage and Laydown Area	0	20	6[2]	20[3]	17[2]	70[3]
Mine Site – West Pit	33[4]	Continuous	65	125	90	160

Source: Barr 2013f.

[1] For all constituents except arsenic, copper, nickel, and antimony, which are modeled with adsorption coefficients that greatly increase chemical migration times.
[2] Concentration decrease for most constituents.
[3] Minimum concentration for most constituents.
[4] Based on deterministic GoldSim run with P50 inputs.

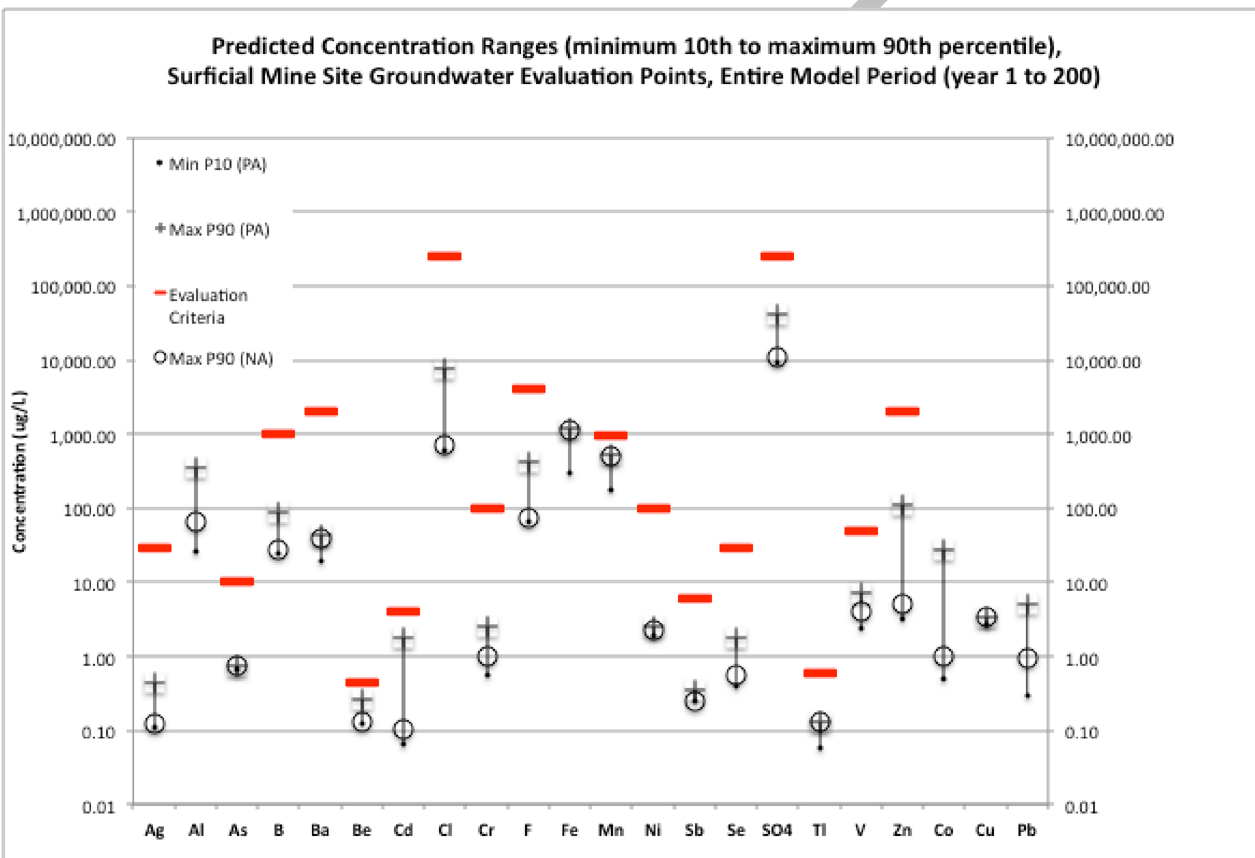
Table 5.2.2-20 indicates that all of the contaminant plumes would reach the Partridge River within the 200-year model duration.

Surficial Groundwater Quality at the Evaluation Locations

Results of the GoldSim water quality modeling were reviewed for all 28 constituents at all five surficial flowpath evaluation locations. A screening process was used to identify any constituents and locations that warranted a more robust examination because modeled concentrations were near water quality evaluation criteria. The screening process involved comparing the single highest monthly P90 water quality prediction from among the 2,400 months covered by the simulation (i.e., 12 months times 200 years) for each constituent at each of the five evaluation locations. These NorthMet Project Proposed Action modeled values were compared with both the NorthMet Project No Action Alternative modeled values and the evaluation criteria discussed previously. Each contaminant that was identified as near the numerical evaluation criteria was then evaluated in more detail.

The screening of maximum predicted 90^{th}-percentile groundwater concentrations of all modeled solutes indicated that none of the solutes across all five flowpaths are predicted to ever exceed the evaluation criteria at the P90 level. The magnitude of the predicted solute concentrations in groundwater are listed in Table 5.2.2-21, and these are illustrated, along with background concentrations (maximum 90^{th}-percentile no-action model) and the range in NorthMet Project

Proposed Action model concentrations (lowest 10th- to highest 90th-percentile over 200-year simulation and across all groundwater model-reporting points), in Figure 5.2.2-20. The proportional increase in the concentrations of each solute (i.e., the ratio of the maximum value under proposed action: maximum value under no action model, based on 90th percentile values) are listed in Table 5.2.2-22 and illustrated graphically in Figure 5.2.2-21. (Note that if the values are the same, the relative change ratio would be 1; values greater than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in an increase in solute concentrations relative to the NorthMet Project No Action Alternative. Conversely, values less than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in a decrease in solute concentrations relative to the NorthMet Project No Action Alternative.)



Note: Groundwater evaluation criteria plotted are listed in Table 5.2.2-2.

Figure 5.2.2-20 Predicted Maximum P90 concentrations of Each Solute versus MCL, Mine Site Surficial Groundwater

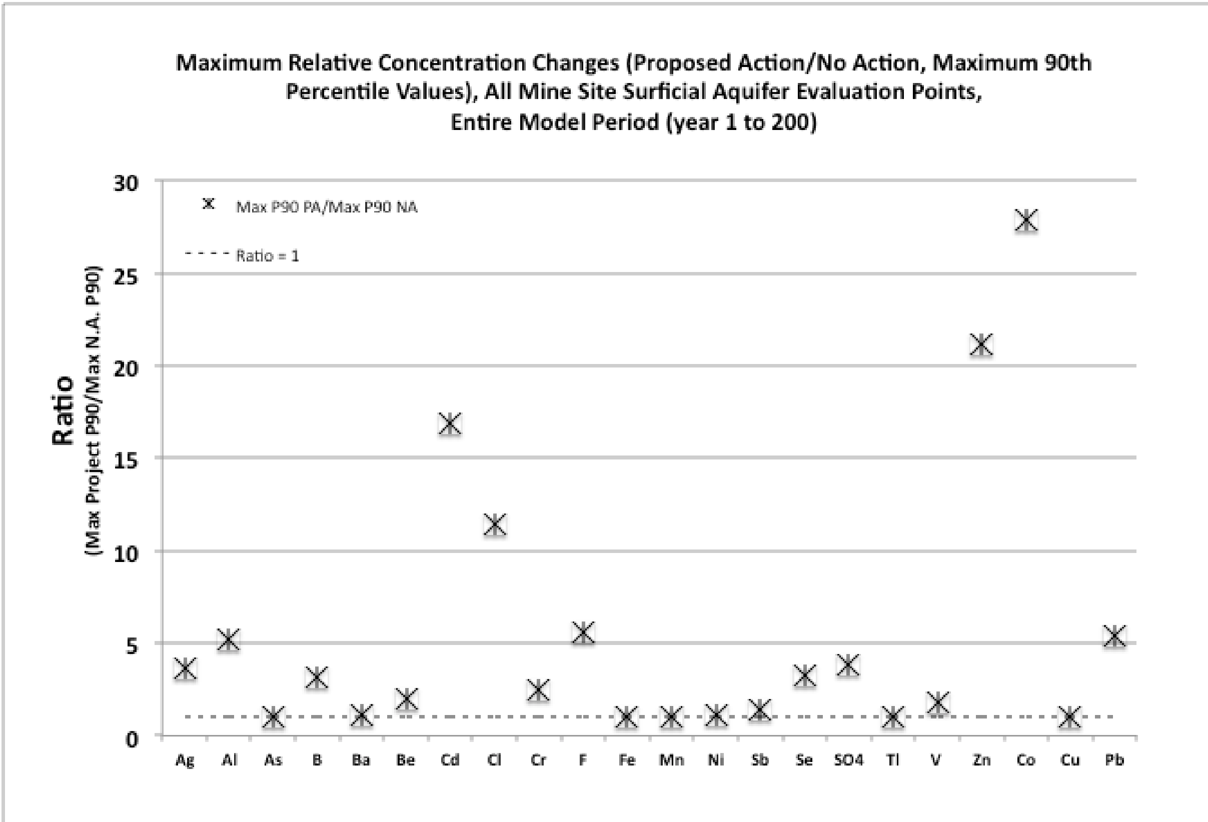


Figure 5.2.2-21 Maximum Relative Concentration Changes (NorthMet Project Proposed Action/No Action Alternative, Maximum 90th Percentile Values), Over the 200-year Simulation Period at All Surficial Aquifer Evaluation Points

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Table 5.2.2-21 Maximum 90th-Percentile Values for Predicted Solute Concentrations in Mine Site Groundwater at the Property Boundary over the 200-year Model Simulation Period

Parameter	Groundwater Evaluation Criterion[1]	Units	East Pit Category 2/3 Flowpath at the Property Boundary		Overburden Storage and Laydown Area Flowpath at the Property Boundary		WWTF Flowpath at the Property Boundary		West Pit (surficial) Flowpath at the Property Boundary	
General			**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**
Alkalinity	NA	mg/L	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7
Calcium	NA	mg/L	26.4	16.8	16.8	16.8	16.8	16.8	33.1	16.8
Chloride	250	mg/L	4.5	0.70	3.7	0.70	0.70	0.70	8.0	0.70
Fluoride	4	mg/L	0.16	0.08	0.42	0.08	0.08	0.08	0.17	0.08
Hardness	NA	mg/L	105	72.3	72.3	72.3	72.6	72.3	148	72.3
Magnesium	NA	mg/L	9.5	7.4	7.4	7.4	7.4	7.4	16.0	7.4
Potassium	NA	mg/L	6.0	1.8	2.6	1.8	1.9	1.8	7.2	1.8
Sodium	NA	mg/L	18.5	5.6	16.0	5.6	5.7	5.6	25.4	5.6
Sulfate	250	mg/L	28.8	10.8	36.5	10.8	11.3	10.8	41.9	10.8
Metals										
Aluminum	NA	µg/L	346	66.9	141	66.9	87.3	66.9	66.9	66.9
Antimony	6.0	µg/L	0.35	0.25	0.29	0.25	0.25	0.25	0.25	0.25
Arsenic	10.0	µg/L	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Barium	2,000	µg/L	43.6	39.4	39.4	39.4	39.4	39.4	39.6	39.4
Beryllium	0.45[2]	µg/L	0.18	0.13	0.16	0.13	0.13	0.13	0.27	0.13
Boron	1,000	µg/L	36.6	27.3	87.3	27.3	27.3	27.3	65.7	27.3
Cadmium	4.0	µg/L	0.76	0.10	0.10	0.10	0.11	0.10	1.8	0.10
Chromium	100	µg/L	1.2	1.0	1.0	1.0	1.0	1.0	2.5	1.0
Cobalt	NA	µg/L	11.9	1.0	1.0	1.0	1.9	1.0	28.0	1.0
Copper	NA	µg/L	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Iron	NA	µg/L	1,186	1,140	1,140	1,140	1,148	1,140	1,140	1,140
Lead	NA	µg/L	1.1	0.93	0.93	0.93	0.94	0.93	5.0	0.93
Manganese	964[2]	µg/L	519	509	509	509	510	509	509	509
Nickel	100	µg/L	2.5	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Selenium	30	µg/L	1.1	0.55	0.62	0.55	0.56	0.55	1.8	0.55
Silver	30	µg/L	0.15	0.12	0.44	0.12	0.12	0.12	0.16	0.12
Thallium	0.60	µg/L	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Vanadium	50	µg/L	4.9	3.9	3.9	3.9	3.9	3.9	7.1	3.9
Zinc	2,000	µg/L	47.6	5.1	5.1	5.1	5.8	5.1	107.9	5.1

Source: Barr 2013f.

1 References for the groundwater evaluation criteria are summarized in Table 5.2.2-2

2 Natural (unaffected) groundwater concentrations for beryllium and manganese (bedrock unit only) at the Mine Site are greater than secondary drinking water standards and/or the HRL (see Table 5.2.2-1). *Minnesota Rules* (Part 7060.0600 subpart 8) states that "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."

Table 5.2.2-22 Maximum Relative Concentration Change (Proposed Action/No Action, Maximum 90th Percentile values), all Groundwater Evaluation Points in the Mine Site Surficial Aquifer

Parameter	Units	East Pit-Category 2/3 Flowpath at the Property Boundary	East Pit-Category 2/3 Flowpath at the Partridge River	Overburden Storage and Laydown Area Flowpath at the Property Boundary	Overburden Storage and Laydown Area Flowpath at the Partridge River	Ore Surge Pile Flowpath at the Partridge River1	WWTF Flowpath at the Property Boundary	WWTF Flowpath at the Partridge River	West Pit (surficial) Flowpath at the Property Boundary	West Pit (surficial) Flowpath at the Partridge River
General										
Alkalinity	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Calcium	Unitless	1.6	1.3	1.0	1.0	1.0	1.0	1.0	2.0	1.7
Chloride	Unitless	6.4	4.3	5.3	2.4	1.0	1.0	1.0	11.4	8.5
Fluoride	Unitless	2.1	1.7	5.6	2.4	1.0	1.0	1.0	2.3	1.9
Hardness	Unitless	1.5	1.2	1.0	1.0	1.0	1.0	1.0	2.1	1.7
Magnesium	Unitless	1.3	1.1	1.0	1.0	1.0	1.0	1.0	2.2	1.8
Potassium	Unitless	3.2	2.4	1.4	1.1	1.0	1.0	1.0	3.9	3.1
Sodium	Unitless	3.3	2.4	2.9	1.5	1.0	1.0	1.0	4.5	3.5
Sulfate	Unitless	2.7	2.0	3.4	1.8	1.0	1.0	1.0	3.9	3.1
Metals										
Aluminum	Unitless	5.2	2.6	2.1	1.3	1.2	1.3	1.2	1.0	1.0
Antimony	Unitless	1.4	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
Arsenic	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Barium	Unitless	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Beryllium	Unitless	1.3	1.2	1.2	1.0	1.0	1.0	1.0	2.0	1.7
Boron	Unitless	1.3	1.2	3.2	1.8	1.0	1.0	1.0	2.4	2.0
Cadmium	Unitless	7.3	4.9	1.0	1.0	1.0	1.1	1.1	16.9	12.4
Chromium	Unitless	1.2	1.1	1.0	1.0	1.0	1.0	1.0	2.5	2.1
Cobalt	Unitless	11.9	7.6	1.0	1.0	1.7	1.9	1.7	27.9	19.9
Copper	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Iron	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lead	Unitless	1.2	1.1	1.0	1.0	1.0	1.0	1.0	5.4	4.1
Manganese	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Nickel	Unitless	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Selenium	Unitless	2.0	1.6	1.1	1.0	1.0	1.0	1.0	3.3	2.6
Silver	Unitless	1.2	1.1	3.6	1.8	1.0	1.0	1.0	1.3	1.2
Thallium	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vanadium	Unitless	1.2	1.1	1.0	1.0	1.0	1.0	1.0	1.8	1.6
Zinc	Unitless	9.3	6.2	1.0	1.0	1.0	1.1	1.1	21.1	15.5

Source: Barr 2013f.

Effects on Bedrock Groundwater Quality

The East Pit and West Pit are predicted to be the only sources of groundwater and contaminant load to bedrock from the Mine Site. Predicted water quality in the bedrock was reviewed; however, the contaminant load had not yet reached the evaluation locations at the end of the 200-year model run because the estimated travel time for groundwater between the mine pits and the bedrock evaluation locations is so long (i.e., over 1,000 years). The effect of the NorthMet Project Proposed Action on bedrock groundwater is considered negligible because groundwater contribution to bedrock from the pits is predicted to be very small (0.09 gpm from the East Pit and 0.08 gpm from the West Pit) and the contaminant load is relatively low and expected to improve over time as the water quality in the pits improves.

Saline Groundwater

Saline groundwater is known to occur in bedrock groundwater across the Canadian Shield (Fritz and Frape 1987; Morton and Ameel 1985). In general, the potential for encountering saline water increases with depth, such that briny groundwater (defined as TDS greater than 35,000 mg/L) may be nearly ubiquitous in bedrock at depths greater than approximately 3,000 ft throughout the Lake Superior basin in Northeast Minnesota (Morton and Ameel 1985), including the Duluth Complex (Rouleau et al. 2003, Bottomley 1996). Brackish to saline groundwater is encountered sporadically in deep (greater than 1,000 ft) bedrock wells in northeastern Minnesota and on the Keweenaw Peninsula and in shallow (less than 300 ft) bedrock wells near Lake Superior (Morton and Ameel 1985). This elevated salinity at depth does not appear to be caused by the bedrock itself as studies have found no particular relationship with rock type (Morton and Ameel 1985). One study concluded that these “brines” were likely formed by the evaporation of seawater during Devonian time about 359 to 419 million years ago (Bottomley 1996).

For the project, the potential of encountering saline groundwater has been raised by the Bands as requiring consideration in the EIS. The concern for the NorthMet Project Proposed Action is whether excavation of the East Pit and West Pit could penetrate zones of saline or briny groundwater or otherwise draw these waters to the surface, thereby increasing the salinity of the West Pit water, which is proposed for treatment at the WWTF.

The closest wells to the PolyMet site that are known to have encountered saline groundwater are located 3.2 miles to the northeast of the East Pit at the former AMAX test shaft at depths of approximately 1,200 to 1,400 ft below the ground surface (Barr 2012v). The maximum depth of the East and West pits, however, are approximately 630 and 696 ft below the ground surface (elevations 800 to 900 ft amsl) and about 500 ft above the elevation where saline water was observed (i.e., elevations 200 to 400 ft amsl).

Bedrock groundwater sampling from the Mine Site also suggests that the pit excavations would not encounter saline groundwater. Sampling from two exploratory boreholes, a water supply well, and nine groundwater monitoring wells drilled at the Mine Site found a maximum chloride concentration of 15.7 mg/L (excluding a value of 93.1 mg/L from the initial sampling at Observation Well-3, where the maximum value detected in subsequent monitoring was 0.81 mg/L) (Barr 2012).

Despite the absence of brine in current wells, the excavation and dewatering of the mine pits would likely draw water up from deeper bedrock below the pits, which could contain elevated chloride concentrations. Bedrock conductivity, however, is much lower than the surficial aquifer, and hydraulic analyses indicate that groundwater inflow to the West Pit would be dominated by water from the surficial aquifer, which is predicted to comprise 83 percent of groundwater inflow at end of mining and increase to 96 percent of inflow as the lake floods (PolyMet 2013i, Table 1-22b).

Regionally, the Federal Hardrock Mineral Prospecting Permits Project ROD recognizes this as a potential risk from exploration drilling (USFS 2012b), noting the possibility that "exploratory drilling could cause pockets of brackish (i.e., salty) groundwater to reach freshwater supplying drinking water wells." This ROD concluded, after consultation with the MDH, that "this scenario is considered unlikely," but "that the risk is not zero" (USFS 2012b).

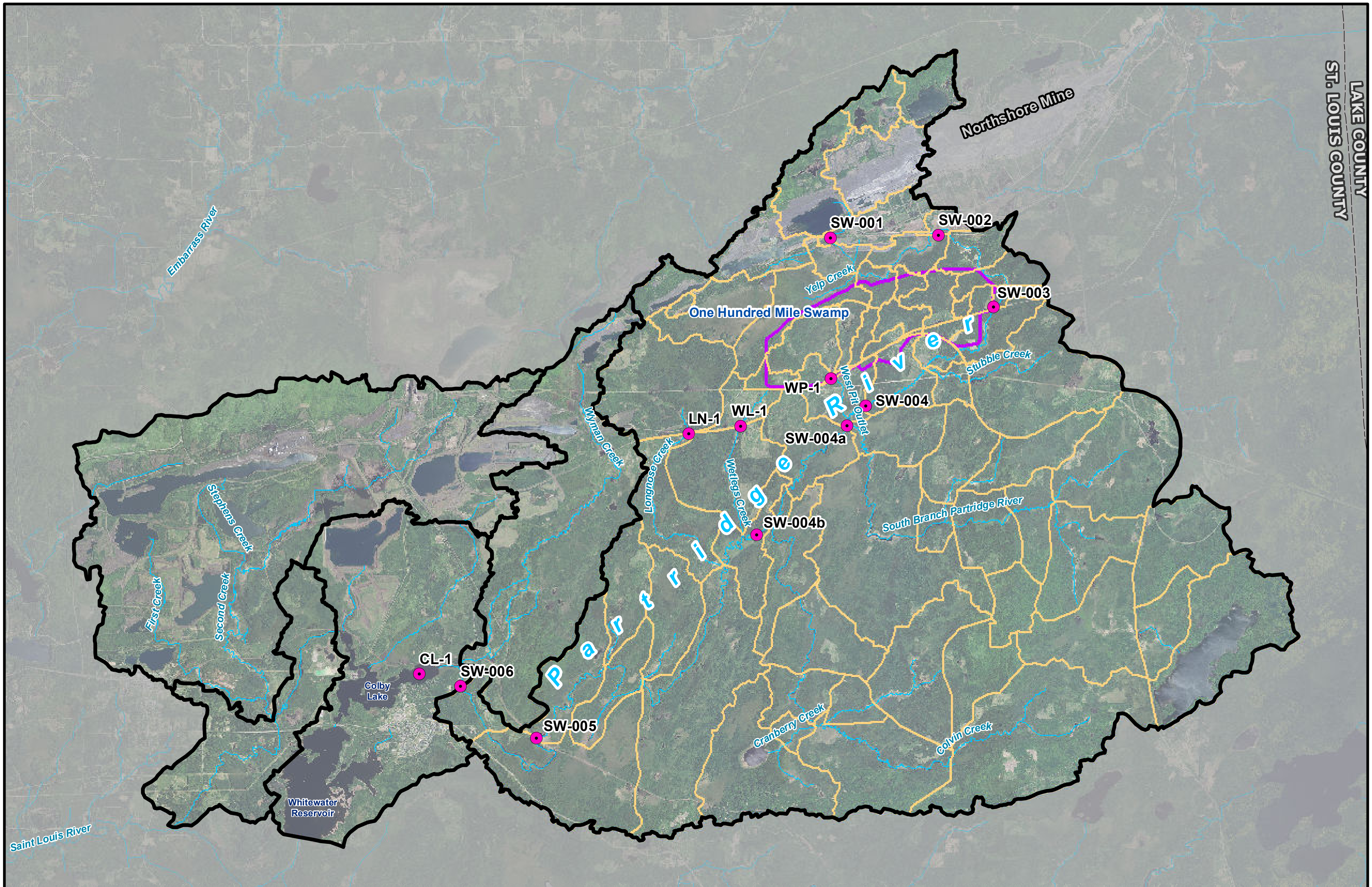
Given that bedrock groundwater monitoring from 12 wells ranging down to 600 ft below the ground surface at the Mine Site did not reveal any elevated chloride concentrations, that the nearest known occurrence of saline water is 3.2 miles from the Mine Site, and that the proposed pit floors would be about 500 ft above the elevation where saline water is known to occur, the risk of encountering saline water is considered low. If encountered, bedrock groundwater inflow to the pits would only be a small component of total pit inflow, so any saline water would be quickly diluted. In addition, any groundwater inflow to the pit during construction would be collected as part of pit dewatering and pumped to the WWTF for treatment. Finally, the chances of a perpetual elevated saline condition is considered small because the pits would flood in closure, producing hydraulic head that inhibits groundwater upwelling. In summary, the risk of elevated saline water inflow to the mine pits is considered small, but, should it occur, would be managed adequately by the WWTF.

Effects on Surface Water Hydrology in the Partridge River Watershed

This section describes the effects of the NorthMet Project on the surface water hydrology of the Partridge River and its tributaries (Figure 5.2.2-22). The NorthMet Project could affect flows in the Partridge River and its tributaries by changing drainage areas, reducing groundwater baseflow contributions during the dewatering and flooding of the East and West pits (i.e., years 1 to 40), and withdrawing water from Colby Lake occasionally for use as makeup water at the processing plant during operations (i.e., years 1 to 20) and for tributary stream flow augmentation in the Embarrass River Watershed (i.e., years 20 to 40).

Changes in Drainage Area

The NorthMet Project would result in changes to drainage areas in some locations that would in turn affect stream flows. These changes primarily include the capture and retention of contact water at the Mine Site and ultimately the use of this water to flood the mine pits. During mine operations and reclamation, surface water runoff from much of the Mine site would be retained until the West Pit floods. Some of these changes in drainage area would only be temporary. This effective reduction in drainage area by the NorthMet Project Proposed Action would reduce both surface runoff (the major streamflow component) and surficial groundwater flow reaching the Partridge River. Table 5.2.2-23 shows the total watershed area and percent watershed area reduction at each surface water evaluation location for selected time periods.



Model Evaluation Locations

Partridge River Watersheds

Upper Partridge River Subwatersheds

Mine Site

Stream/River

US Army Corps of Engineers
St. Paul District

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

N W E S

0 0.5 1 2 3 Miles

Figure 5.2.2-22
Partridge River Subwatersheds and Surface Water Evaluation Locations
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

DRAFT SUBJECT TO REVISION

April 2013

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Table 5.2.2-23 Total Watershed Area (acres) and Percent Watershed Area Reduction for the Partridge River Resulting from the NorthMet Project Proposed Action

Location/ Year	SW-001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	Colby Lake
Year Zero, No Action Alternative	670	4,508	5,550	10,566	30,557	45,665	59,065	62,056	74,636
Year 11	670 0%	4,264 5.4%	5,301 4.5%	9.907 6.2%	29,041 5.0%	44,149 3.3%	57,549 2.0%	60.540 2.4%	73,120 2.0%
Year 20	670 0%	4,484 0.5%	5,521 0.5%	10,126 0.4%	29,504 3.4%	44,612 2.3%	58,012 1.8%	61,003 1.7%	73,583 1.4%
Year 40, Long term	670 0%	4,462 1.0%	5,504 0.8%	10,397 1.6%	29,903 2.1%	45,011 1.4%	58,411 1.1%	61,402 1.1%	73,982 0.9%

Source: Barr 2013a.

The maximum watershed area reduction for any modeled location along the Partridge River would be 6.2 percent at SW-004, during year 11 of operations. Maximum long-term watershed area reduction of 2.1 percent would occur at SW-004a. Other years during operation were not tabulated because they would be less than those occurring during year 11.

These proposed modifications to drainage areas were taken into consideration in the XP-SWMM modeling and are not expected to be significant.

XP-SWMM Modeling Results for the Partridge River

The water resources evaluation criteria (Section 5.2.2.1) established 28 flow parameters, known as Richter Statistics, to be evaluated for the Partridge River. Section 5.2.2.1.6 discusses these parameters. The XP-SWMM model was run for the NorthMet Project No Action Alternative condition and several selected years during operations while the West Pit is filling, and, over the long term, to determine the changes to each parameter at each stream location. Given the relatively small watershed area changes (watershed area reductions will approximate flow reductions), only selected modeling results are presented here to demonstrate the range of potential hydrologic effects. Effects on Colby Lake were not evaluated with the XP-SWMM model; water level changes to Colby Lake and Whitewater Reservoir are addressed in the next section. Table 5.2.2-24 summarizes the XP-SWMM results for selected flow parameters and stream locations.

Table 5.2.2-24 Modeled Percent Change in Selected Streamflow Parameters at Selected Locations in the Partridge River

Location/Flow Parameter	SW-002 Year 11	SW-002 Long Term	SW-004 Year 11	SW-004 Long Term	SW-004a Year 11	SW-004a Long Term	SW-006 Year 11	SW-006 Long Term
Average Annual Flow	-4.9%	NC	-4.3%	NC	-4.4%	+1.0%	-1.7%	NC
Average Feb. Flow	-5.3%	NC	-4.5%	NC	-4.5%	6.5%	-1.8%	+3.7%
Average April Flow	-5.3%	NC	-4.7%	NC	-4.5%	NC	-2.0%	NC
Annual Max 3-day Flow	-4.6%	NC	-2.8%	-2.6%	-3.5%	NC	-2.1%	NC
Annual Min 3-day Flow	-6.7%	NC	-7.4%	-2.7%	-7.9%	+38.1%	-3.4%	+15.4%
Average 30-day Low Flow	-5.7%	-1.4%	-6.7%	-2.3%	-6.1%	+21.9%	-2.6%	+9.3%
Mean Duration of High Pulses	-1.8%	-1.8%	-2.4%	-1.6%	-2.9%	-2%	-1.3%	-1.3%
Mean Duration of Low Pulses	NC	NC	+3.2%	NC	NC	NC	-5.9%	-6.9%

Source: Barr 2012g

NC: Indicates modeled change less than 1 percent.

It is apparent from Table 5.2.2-24 that virtually all effects on streamflow during the year of maximum watershed reduction (year 11) would be negative. The largest modeled effect, less than an 8 percent reduction, would occur during low-flow conditions. After the West Pit is filled with water, discharge from the WWTF to the West Pit receiving stream would more than compensate for the reduced low flows at some locations. The maximum modeled effect is at location SW-004a, just downstream of where the WWTF discharge would enter the Partridge River. Here, the annual minimum 3-day flow and average annual 30-day low flow would increase by about 38 and 22 percent, respectively. Although these percent increases would be relatively large compared to other alterations, the actual flow increases would be only 0.6 cfs. The NorthMet Project would have little effect on high flows, as evidenced by no change in the average April flow and the annual maximum 3-day flow.

Effects on the Hydrology of the Partridge River Tributary Streams

The NorthMet Project Proposed Action is not expected to have any measureable effects on surface water hydrology of the tributary streams along the Transportation and Utility Corridor or at the processing plant. PolyMet proposes to augment flows in Second Creek to mitigate the hydrologic effect associated with the current and proposed ongoing seepage collection system. This stream flow augmentation program is described in more detail in Section 5.2.2.3.3.

Effects on Colby Lake Water Levels

The effect of the NorthMet Project Proposed Action on water levels in Colby Lake is related to any changes in Partridge River inflow as well as water withdrawals to provide water for process water makeup and Embarrass River tributary stream flow augmentation (see Section 5.2.2.3.3 for additional details regarding the proposed flow augmentation program).

The XP-SWMM modeling for SW-006, just upstream of Colby Lake, shows minor reductions in Partridge River low flows (i.e., 3 percent reduction in the 30-day low flow, which is equivalent to about a 0.15 cfs reduction). On an annual average basis, inflow to Colby Lake would be reduced a maximum of less than 2 percent, or about 1 cfs. Over the long term, inflow to Colby Lake would be increased about 0.5 cfs.

NorthMet Project Proposed Action makeup water demand from Colby Lake, including water pumped for augmentation to the Embarrass River tributary streams, would be a maximum average annual demand of about 2,030 gpm during operations (for both process makeup water and stream augmentation) and about 1,600 gpm during reclamation (all for stream augmentation); no water would be needed from Colby Lake during closure.

Therefore, the maximum, combined effect of Partridge River flow reduction plus pumping from Colby Lake for makeup water and flow augmentation, would be about 2,500 gpm (about 5.5 cfs). The NorthMet Project DEIS (October 2009) evaluated two potential Colby Lake withdrawal rates, 3,500 gpm and 5,000 gpm, for a previous NorthMet Project design. The model assumed transfer of water from Whitewater Reservoir in order to maintain water levels above the critical outflow elevation of 1,438.5 ft at all times in Colby Lake, which is required under MDNR Water Appropriation Permit 1949-0135.

At 3,500 gpm withdrawal and average flow conditions, the average Colby Lake drawdown was modeled at 0.01 ft, with an average annual water level fluctuation of about 3.6 ft, compared to 3.9 ft for zero withdrawal. Whitewater Reservoir would also be affected by water withdrawals as it is used to help maintain water levels in Colby Lake. Under this 3,500 gpm withdrawal and average flow conditions scenario, drawdown on Whitewater Reservoir was predicted to be about 0.4 ft with a maximum annual fluctuation of about 4.2 ft compared to about 2.9 ft for zero withdrawal. Environmental consequences of the drawdown on wetlands and aquatic resources are discussed in Sections 5.2.3 and 5.2.6.

It is reasonable to assume that the effects of PolyMet's proposed withdrawal of less than 3,500 gpm would be no worse on Colby Lake and Whitewater Reservoir water levels than this modeled 3,500 gpm withdrawal. These anticipated effects are well within the range of effects experienced during the former LTVSMC taconite mining operations.

Effects on the Hydrology of the Lower Partridge River

Existing flow conditions in the Lower Partridge River can be estimated by examining the flow record (i.e., 1942 to 1982) at USGS gaging station 04016000, which was located approximately 1.5 miles downstream of Colby Lake. Historic hydrologic alterations to Partridge River watershed area caused by former LTVSMC operations are likely present in the USGS flow data, while alterations from the present Mesabi Nugget operations are not considered. Notwithstanding these effects, the historic flow records can be used to provide a rough estimate of NorthMet Project Proposed Action effects on this part of the Partridge River.

The record shows average monthly flows varying from about 17 cfs during January to about 333 cfs during April, with an average annual flow of about 112 cfs. Assuming an average, annual effect on Colby Lake of about 5.5 cfs, the average annual flow reduction at the gage site would be about 5 percent. The 5.5 cfs withdrawal cannot simply be subtracted from each month to estimate effects on low or high flows because of required transfer of water from Whitewater Reservoir when Colby Lake drops to elevation 1,439.0. Given this requirement to supplement low flows by transferring water from the reservoir, it is expected that effects on low flows at the gage station would be negligible. Effects on high flows would be less than the average, and would proportionately diminish as the flow rises. It should be noted that high flows downstream of Colby Lake are also substantially reduced because of water transfers to the reservoir during high runoff periods. Therefore, the NorthMet Project Proposed Action is expected to have negligible effects on flow in the Lower Partridge River.

Effects on Surface Water Quality

The NorthMet Project Proposed Action may affect the water quality of the Partridge River and its tributaries that drain the Mine Site, Transportation and Utility Corridor, and the processing plant area. PolyMet proposes to treat, reuse, and recycle water, resulting in no direct surface water discharges until the West Pit overflows in approximately year 40. Nevertheless, several potential pathways for surface water quality effects remain, including domestic wastewater, non-contact stormwater runoff, seepage from waste rock stockpiles and the pits, WWTF effluent after the West Pit fills, and eventually pit lake overflow through a non-mechanical treatment system.

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 would be designed to adequately manage the domestic wastewater requirements of the NorthMet Project Proposed Action, so this potential contaminant source is not discussed further.

The other predicted effects of the NorthMet Project Proposed Action on surface water quality in the Upper Partridge River, Colby Lake, and the Lower Partridge River (except for potential non-mechanical treatment) are discussed below.

Effects on the Upper Partridge River

Water quality in the Upper Partridge River is already affected by discharges from the Northshore Mine. As mentioned above, PolyMet does not propose any surface water discharges until the West Pit floods around year 40. However, non-contact stormwater runoff, unrecoverable groundwater seepage from the five groundwater flowpaths (i.e., from the waste rock stockpiles, pits, Ore Surge Pile, WWTF, and Overburden Storage and Laydown Area), and the WWTF discharge would all serve as potential contaminant sources. Each of these potential contaminant sources is discussed below and then the predicted overall effect of these sources on water quality in the Upper Partridge River is evaluated.

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).

Liner Leakage and Pit Seepage

The WWTF ponds, the Ore Surge Pile, Category 2/3 Stockpile, and Category 4 Stockpile all have compacted soil and geomembrane liners. Percolating water above the liner would be collected and pumped to the WWTF for treatment. Some water is modeled to leak through the liners as a result of tears or defects in the geomembrane liners.

The quantity of water leaking through the liners is determined by the liner design and effectiveness. The Hydrologic Evaluation of Landfill Performance model was used to help estimate liner leakage. Uncertainty analysis was used for three key input variables (i.e., liner slope, subgrade permeability, and frequency of liner defects) with The Hydrologic Evaluation of Landfill Performance model (PolyMet 2013i).

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). Concerns regarding geomembrane liners primarily relate to the potential for differential settlement to cause tears and for it to degrade over time. These concerns are ameliorated to a large extent by the fact that all of the proposed liner systems are temporary. The Ore Surge Pile and Category 2/3 Stockpile and Category 4 Stockpile would be removed, including the liners, by year 20. The lined WWTF West equalization ponds would not be used after operations end (year 22) as the inflow to the WWTF would be reduced and there would not be the same need for water storage. The lined WWTF East equalization pond would continue to be used to provide surge capacity through the reclamation period.

In closure, once water in the flooded pits rises above the top of bedrock, a small volume of water is predicted to flow from the pits to the downgradient surficial aquifer. Groundwater outflow would contribute flow to the West Pit Flowpath, which flows downgradient to the Partridge River.

Liner leakage from the Overburden Storage and Laydown Area, WWTF, Ore Surge Piles, and Category 2/3 Stockpile, as well as seepage from the East Pit and West Pit all follow the hydraulic gradient and eventually reach the Partridge River. The flow rates from these various contaminant sources are generally low, ranging from about 0.8 gpm from the WWTF to 23.3 gpm from the Category 2/3 Stockpile. Some of these sources are only temporary, while others are essentially permanent, although the contribution of contaminant load would be expected to decline over time (e.g., from the East Pit and West Pit). In addition, the time for these contaminant loads to travel from its source to the Partridge River varies, primarily because of distance, from 34 years up to 173 years. In summary, the contribution of contaminant load to the Partridge River from these groundwater seepage sources varies considerably over time.

Table 5.2.2-25 Liner Leakage/Pit Outflow Characteristics (Based on GoldSim Deterministic Run with P50 Inputs)

Contaminant Source	Flow Rate (gpm)	Duration of Source (Years)	Mine Year when Arrives at Partridge River
East Pit	3.7[(1)]	Mine Years 21+	110
Category 2/3 Stockpile	0.019	Mine Years 0-20	30
Ore Surge Pile	0.0012	Mine Years 0-21	90
WWTF	0.013	Mine Years 0-35	95
Overburden Storage and Laydown Area	14.0	Mine Years 0-20	17[(2)]
West Pit	6.1[(1)]	Mine Years 33+	90

1 Pit water into groundwater flowpath.
2 Concentration decrease.

<u>*Wastewater Treatment Facility Discharges*</u>

PolyMet proposes a WWTF at the Mine Site to treat influent from the East Pit (operations and reclamation only), contact stormwater (operations and reclamation only), Plant Site WWTP reject concentrate, (operations and reclamation only), Category 1 Stockpile drainage (operations, reclamation, and closure), the West Pit (reclamation only), and the West Pit overflow (closure only). The process water at the Mine Site would be combined into three waste streams for treatment at the WWTF. Construction water would be treated in a construction water stream and would only be needed through approximately year 11. Process water containing relatively high levels of metals and sulfate (drainage from the temporary Category 2/3 Stockpile and Category 4 Stockpile liners and the temporary Ore Surge Pile liner) would be stored in the West Equalization Basin and routed to the chemical precipitation treatment train. Process water containing relatively low concentrations of metals and sulfate (drainage from haul roads, the Rail Transfer Hopper, pit dewatering and Category 1 Stockpile drainage) would be stored in the East Equalization Basin and routed to the membrane filtration treatment train. The WWTF effluent would flow by gravity to the CPS pond to be blended with the Overburden Storage and Laydown Area runoff prior to being pumped through the TWP for use at the Tailings Basin or used to supplement flooding of the East Pit after approximately year 11 (PolyMet 2013e). Table 5.2.2-26 presents the estimated average Mine Site process water flow rates by source for the WWTF's design year (i.e., maximum annual average flow year, which are years 14, 25, and 75 for operations, reclamation, and closure, respectively).

Table 5.2.2-26 Mine Site Process Water Flows to the Wastewater Treatment Facility

	90th Percentile Estimated Average Annual Flow (gpm)		
Source	**Operations[2]**	**Reclamation[3]**	**Closure[4]**
East Pit	420	1750[(5)]	--
Central Pit	60	--	--
West Pit	390	--	400
Haul Roads and Rail Transfer Hopper	65	--	--
Category 1 Stockpile	385	10	10[6]
Category 2/3 Stockpile	145	--	--
Ore Surge Pile	25	--	--
Category 4 Stockpile	0	--	--
WWTP Reject Concentrate	150	175	--
Total[1]	1550	1,925	400

Source: PolyMet 2013g, Table 2-1.

1 Flows are rounded to the nearest 5 gpm; column values do not sum to 90th percentile total value due to probabilistic modeling (P90 of totals is not equivalent to the total of the P90s).
2 Estimates based on Reference (3) for year 14 (Design Year), 90th Percentile.
3 Estimates based on Reference (3) for year 25, 90th Percentile
4 Estimates based on Reference (3) for year 75, 90th Percentile.
5 Flow value is total of East Pit and Central Pit.
6 Flow is included in the West Pit closure estimate.

Actual flow rates would vary daily and seasonally throughout the 20 years of mine operations. Peak influent flows to the WWTF are anticipated to occur during spring snow melt. Because influent flow rates to the WWTF would vary significantly over the life of the NorthMet Project Proposed Action and within any given year, the WWTF design includes two equalization basins that would store influent that exceeds the WWTF's treatment capacity. The WWTF equalization basins are designed for the spring snowmelt when the Mine Sit would be at its maximum area. In the event of an extreme event (e.g., 100-year storm), excess water would remain in the mine pits, which essentially have unlimited storage capacity, with mine operations in the pits temporarily shut down (see Mine Site Water Management Plan). Even during an extreme event, no untreated water would be discharged to a natural waterbody.

The WWTF design for operations and reclamation includes chemical precipitation and membrane filtration. During mine operations, the treated effluent from the WWTF would be mixed with the runoff collected from the Overburden Storage and Laydown Area in the CPS pond where it is pumped either to the Tailings Basin pond (for reuse as process water at the Beneficiation Plant) or to help flood the East Pit (after mining would be completed in year 11). During mine reclamation, the WWTF is primarily used to treat the East Pit water to reduce the load from the backfilled waste rock, and the effluent is primarily returned to the East Pit.

During mine closure, the WWTF is primarily used to treat water from Category 1 Stockpile drainage and the flooded West Pit water. Since the West Pit would now be flooded, the WWTF would begin in closure to discharge effluent to a natural waterbody (i.e., an unnamed intermittent stream referred herein as the West Pit Discharge Stream that flows to the Partridge River just upstream of SW-004a) and would need to meet State of Minnesota water quality standards. The proposed WWTF design for closure would add an RO unit prior to discharge to enhance contaminant removal and assure compliance with water quality standards.

Table 5.2.2-27 presents the target WWTF effluent concentrations for the different mine phases. Pilot testing of a WWTF with RO demonstrated that all of the target closure effluent concentrations can be achieved with the planned WWTF design (Barr 2013g).

Table 5.2.2-27 Wastewater Treatment Facility Preliminary Water Quality Targets

Parameter[1]	Operations	Reclamation	Long-term Closure	Basis	Potential Maximum Treated Water Concentrations at Discharge Location	
Metals/Inorganics (µg/L, except where noted)					**SD-006**	**SD-026**
Aluminum	125	125	125	M.R.[4] 7050.0222 Class 2B (chronic standard)	125[4]	125[4]
Antimony	31	31	31	M.R.[4] 7050.0222 Class 2B (chronic standard)	31[4]	31[4]
Arsenic	10	10	10	Federal Standard (Primary MCLs)	53[4]	53[4]
Barium	2000	2000	2000	Minn. Groundwater (HRL, HBV, or RAA)		
Beryllium	4	4	4	Federal Standard (Primary MCLs)		
Boron	500	500	500	M.R.[4] 7050.0224 Class 4A (chronic standard)	500[4]	--[5]
Cadmium[3]	5.1	4.2	2.5	M.R.[4] 7052.0100 Class 2B (chronic standard)		
Chromium[2]	11	11	11	M.R.[4] 7052.0100 Class 2B (chronic standard)	11[2]	11[2]
Cobalt	5	5	5	M.R.[4] 7050.0222 Class 2B (chronic standard)	5[4]	--[5]
Copper[3]	20	17	9.3	M.R.[4] 7052.0100 Class 2B (chronic standard)	30[4]	30[4]
Iron	300	300	300	Federal Standard (sMCLs)	1000 (2000)[5]	300[4]
Lead[3]	10.2	7.7	3.2	M.R.[4] 7050.0222 Class 2B (chronic standard)	19 [4]	19[4]
Manganese	50	50	50	Federal Standard (sMCLs)		--[5]
Nickel[3]	113	94	52	M.R.[4] 7052.0100 Class 2B (chronic standard)		
Selenium	5	5	5	M.R.[4] 7052.0100 Class 2B (chronic standard)	5[4]	5[4]
Silver	1	1	1	M.R.[4] 7050.0222 Class 2B (chronic standard)	1[4]	1[4]
Thallium	0.56	0.56	0.56	M.R.[4] 7050.0222 Class 2B (chronic standard)	0.56[4]	0.56[4]
Zinc[3]	260	216	120	M.R.[4] 7050.0222 Class 2B (chronic standard)	388[4]	388[4]
General Parameters (mg/L, except where noted)						
Chloride (mg/L)	230	230	230	M.R. 7050.0222 Class 2B (chronic standard)	230[4]	230[4]
Fluoride (mg/L)	2	2	2	Federal Standard (sMCLs)	2[4]	-- [1]
Hardness (mg/L)	250	200	100	M.R[4] 7050.0100 Class 2B (chronic standard)	250[4]	250[4]
Sodium	60% of cations	60% of cations	60% of cations	M.R[4] 7050.0224 Class 4A (chronic standard)	1[4]	--[4]

Parameter[1]	Operations	Reclamation	Long-term Closure	Basis	Potential Maximum Treated Water Concentrations at Discharge Location	
Sulfate (mg/L)	250	150	10	Operations: Federal Standard (sMCLs) Long-term closure: M.R. 7050.0224 Class 4A (chronic standard)	10[(6)]	10[(6)]

Source: PolyMet 2013g, Table 2-3; Barr 2013g, Table 3.

1 The Process Water Quality Targets parameter list has been updated from RS29T to include only the parameters modeled in GoldSim.
2 The Chromium (+6) standard of 11 µg/L is used rather than the total Chromium standard to be conservative.
3 Standard based on hardness.
4 *Minnesota Rules.*
5 Monthly Average (Monthly Maximum) Dissolved as specified in NPDES permit.
6 Assumed 10 mg/L sulfate standard.

Comparison of Contaminant Sources

The GoldSim model enables the identification of "culpability," or the relative contribution of various contaminant sources to the overall contaminant load at a specific evaluation location. Table 5.2.2-28 presents an illustrative example of the culpability analysis using two representative solutes of interest (copper and sulfate) at evaluation location SW004a during representative years for operations, reclamation, and closure periods. The culpability identifies 12 sources of copper and sulfate at this evaluation location. In addition to the nine NorthMet Project Proposed Action-related sources (i.e., five surficial aquifer flowpaths, three bedrock flowpaths, and the WWTF discharge), three non-NorthMet Project Proposed Action-related sources are identified (i.e., background groundwater, background surface water, and the Northshore Pit discharge).

Table 5.2.2-28 Culpability Analysis Using Copper and Sulfate at SW-004a

	Copper Load (% of total)			Sulfate Load (% of total)		
Contaminant Source	**Operations Year 12**	**Reclaim Year 25**	**Closure Year 200**	**Operations Year 12**	**Reclaim Year 25**	**Closure Year 200**
Background Groundwater	35.8%	37.2%	27.2%	16.2%	17.3%	15.7%
Background Runoff	52.6%	50.9%	39.1%	65.5%	63.5%	62.0%
PMP Dewatering	9.2%	9.4%	6.8%	17.2%	18.1%	16.2%
East Pit/Category 2/3 Surficial GW	1.1%	1.6%	1.1%	0.5%	0.7%	0.8%
Ore Surge Pile Surficial GW	0.2%	0.3%	0.2%	0.1%	0.1%	0.1%
WWTF Surficial GW	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Overburden Storage and Laydown Area Surficial GW	0.9%	0.5%	0.3%	0.4%	0.2%	0.2%
West Pit Surficial GW	0.0%	0.0%	0.4%	0.0%	0.0%	0.6%
East Pit Bedrock GW	0.0%	~0.0%	~0.0%	0.0%	~0.0%	~0.0%
West Pit Bedrock GW (both)	0.0%	0.0%	~0.0%	0.0%	0.0%	~0.0%
WWTF discharge	0.0%	0.0%	24.7%	0.0%	0.0%	4.3%

Source: Barr 2013f

GW = Groundwater

As Table 5.2.2-28 indicates, the primary source of contaminant load for both copper and sulfate at SW-004a for operations, reclamation, and closure phases are the non-project related sources—background groundwater, surface water, and Northshore Pit dewatering, although the WWTF discharge does represent a significant source of copper in closure.

Overall Effects on Upper Partridge River Water Quality

Results of the GoldSim water quality modeling were reviewed for all 28 constituents at all seven Upper Partridge River evaluation locations. A screening process was used to identify any constituents and locations that warranted a more robust examination (Table 5.2.2-29). The screening process involved comparing the single highest monthly P90 water quality prediction from among the 2,400 months covered by the simulation (i.e., 12 months times 200 years) for each constituent for each of the seven evaluation locations. These NorthMet Project Proposed Action modeled values were compared with both the NorthMet Project No Action Alternative modeled values and the evaluation criteria identified in Section 5.2.2.1. If the maximum monthly P90 concentration exceeded the evaluation criteria, the screening process identified it for further analysis.

Table 5.2.2-29 Maximum Modeled Monthly P90 Surface Water Concentrations for the Mine Site

				SW-002		SW-003		SW-004		SW-004a		SW-004b		SW-005(3)		SW-006	
Parameter	**Partridge Evaluation Criteria[1]**	**Colby Evaluation Criteria[1]**	**Units**	**Proposed Project**	**No Action**	**Proposed Project**	**No Action**	**Proposed Project**	**No Action**	**Proposed Project**	**No Action**	**Proposed Project**	**No Action**	**Proposed Project**	**No Action**	**Proposed Project**	**No Action**
General																	
Alkalinity	NA	NA	mg/L	126.8	126.8	128.2	128.1	128.6	128.6	128.8	128.9	128.8	128.9	128.8	129.0	128.8	129.0
Calcium	NA	NA	mg/L	30.0	30.0	30.0	30.0	30.1	30.1	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
Chloride	230	230	mg/L	21.8	21.8	22.0	22.0	22.5	22.5	22.8	22.8	22.8	22.9	22.9	23.0	22.9	22.9
Fluoride	NA	4	mg/L	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Hardness	500	500	mg/L	118.1	118.1	118.2	118.2	118.4	118.4	118.5	118.6	118.5	118.6	118.6	118.6	118.6	118.6
Magnesium	NA	NA	mg/L	13.5	13.5	13.6	13.5	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Potassium	NA	NA	mg/L	3.59	3.59	3.59	3.59	3.61	3.61	3.61	3.63	3.63	3.63	3.63	3.63	3.63	3.63
Sodium	NA	NA	mg/L	17.7	17.7	17.7	17.7	18.0	17.9	18.9	18.2	18.3	18.2	18.3	18.2	18.3	18.2
Sulfate	NA	250	mg/L	20.9	20.9	20.6	20.6	20.9	19.5	19.4	19.4	19.4	19.4	**19.4**	**19.4**	19.4	19.4
TDS	700	700	mg/L	183.8	183.8	184.6	184.4	186.2	184.7	186.1	185.5	185.5	185.6	185.6	185.7	185.6	185.6
Metals Total																	
Aluminum	125	125	µg/L	**165.4**	**165.4**	**165.8**	**165.6**	**169.1**	**168.9**	**171.7**	**173.5**	**173.4**	**173.7**	**173.7**	**173.9**	**173.7**	**173.9**
Antimony	31	5.5	µg/L	1.66	1.66	1.66	1.66	1.66	1.66	3.97	1.67	3.1	1.67	2.27	1.67	2.09	1.67
Arsenic	53	2	µg/L	5.96	5.96	5.77	5.79	5.17	5.1	5.6	3.91	4.47	2.89	2.88	1.76	2.48	1.52
Barium	NA	2000	µg/L	13.6	13.7	14.5	14.6	18.1	17.8	27.8	25.2	28.4	26.5	26.1	24.3	25.4	23.8
Beryllium	NA	4	µg/L	0.11	0.11	0.11	0.11	0.12	0.11	0.19	0.12	0.18	0.12	0.15	0.12	0.14	0.12
Boron	500	500	µg/L	174.5	174.4	175.8	175.6	177.8	177.8	179.6	179.7	180.0	179.9	180.1	180.3	180.3	180.2
Cadmium	1.3 - 2.7(2)	5	µg/L	0.12	0.12	0.12	0.12	0.13	0.12	0.61	0.12	0.45	0.12	0.31	0.12	0.27	0.12
Chromium	11	11	µg/L	1.77	1.77	1.78	1.78	1.84	1.84	1.87	1.86	1.87	1.87	1.87	1.87	1.87	1.87
Cobalt	5	2.8	µg/L	0.58	0.58	0.59	0.59	1.1	0.63	2.18	0.74	1.81	0.76	1.37	0.72	1.25	0.71
Copper	4.2 - 10.5(2)	NA	µg/L	2.02	2.03	2.05	2.07	2.27	2.21	4.28	2.57	3.93	2.64	3.27	2.53	3.13	2.5
Iron	NA	300	µg/L	2,445	2,444	2,477	2,471	2,547	2,547	2,577	2,593	2,587	2,594	2,592	2,602	2,592	2,602
Lead	0.97 - 3.8(2)	NA	µg/L	0.44	0.44	0.45	0.45	0.53	0.51	1.28	0.64	1.14	0.66	0.91	0.6	0.85	0.58
Manganese	NA	50	µg/L	184.5	184.6	188.3	188.3	217.4	219.5	304.0	307.8	331.1	329.5	320.2	318.9	315.1	317.5
Nickel	23.6 – 58.7(2)	NA	µg/L	2.91	2.91	2.91	2.91	2.95	2.95	15.7	2.98	12.3	2.99	8.26	2.99	7.32	2.99
Selenium	5	5	µg/L	0.61	0.61	0.61	0.61	0.61	0.61	1.27	0.61	1.07	0.61	0.84	0.61	0.79	0.61
Silver	1	1	µg/L	0.12	0.12	0.12	0.12	0.12	0.12	0.14	0.12	0.13	0.12	0.13	0.12	0.13	0.12
Thallium	0.56	0.28	µg/L	0.27	0.27	0.26	0.26	0.25	0.24	0.22	0.21	0.18	0.18	0.13	0.13	0.12	0.12
Vanadium	NA	NA	µg/L	5.39	5.39	5.4	5.39	5.41	5.41	6.07	5.43	5.61	5.43	5.44	5.43	5.44	5.43
Zinc	54.2 – 135(2)	NA	µg/L	26.0	26.0	26.3	26.3	27.1	27.1	33.5	27.4	28.5	27.6	27.7	27.5	27.7	27.5

Source: Barr 2013f.

1 Some stream standards vary with hardness.
2 Range of P10 to P90 standard associated with varying hardness; applicable standard varies with modeled or measured hardness at evaluation location.
3 10 mg/L wild rice standard applies from SW-005 to Colby Lake. See next section for detailed evaluation.
Note: Bold numbers indicate modeled concentrations above the SDEIS evaluation criteria at the P90 level.

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The screening table clearly shows that the maximum monthly modeled P90 concentrations for the NorthMet Project Proposed Action are similar to the corresponding modeled values for the NorthMet Project No Action Alternative for most of the constituents. Some of the NorthMet Project Proposed Action P90 values—such as those for antimony, arsenic, cadmium, cobalt, copper, lead, nickel, and selenium at SW-004a, SW-004b, SW-005, and SW-006—are noticeably higher than the NorthMet Project No Action Alternative, but the NorthMet Project Proposed Action values all remain well below the applicable evaluation criteria.

Table 5.2.2-29 above also shows that the maximum monthly P90 values for the NorthMet Project Proposed Action do not exceed the applicable evaluation criteria for any of the constituents except aluminum (at all locations) and possibly sulfate (at SW-005), for any time during the 200-year modeling period. A detailed evaluation of these two constituents is provided below.

Tables 5.2.2-30, 5.2.2-31, and 5.2.2-32 below compare the P10, P50, and P90 for NorthMet Project Proposed Action and NorthMet Project No Action Alternative modeled concentrations for selected representative solutes of interest at representative years during mine operations, reclamation, and closure at SW-004a, which is the evaluation location where the NorthMet Project Proposed Action would have its greatest effects on water quality for most constituents. As these data show, the water quality is predicted to be essentially the same between the NorthMet Project No Action Alternative and the NorthMet Project Proposed Action for operations and reclamation. This result is not unexpected as none of the groundwater contaminant loads would reach the Partridge River until year 34 at the earliest and there would be no surface water discharge from the NorthMet Project Proposed Action until year 40. By year 200 in closure, which reflects a long-term steady state condition, the WWTF would be discharging and all groundwater contaminant loads would have reached the Partridge River (except negligible contributions from the bedrock flowpaths). All of the key constituents would meet water quality evaluation criteria. Although the NorthMet Project Proposed Action evaluation criteria focuses on the P90 values (e.g., a reasonable worst case), the most probable result would be closer to the P50 value, while the P10 value represents a reasonable best case in terms of modeled water quality effects from the NorthMet Project Proposed Action.

Table 5.2.2-30 Comparison of the P10, P50, and P90 Values for Proposed Action and No Action Modeled Concentrations at SW-004a for Selected Key Constituents, Year 12

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Sulfate	NA	mg/L	8.3	8.4	14.2	14.4	19.2	19.2
Arsenic	53	µg/L	1.3	1.3	2.9	3.0	3.8	3.8
Copper	9.5	µg/L	1.4	1.4	2.1	2.2	2.5	2.6
Lead	3.3	µg/L	0.4	0.4	0.5	0.5	0.6	0.6
Nickel	53	µg/L	1.3	1.4	1.7	1.7	2.9	2.9
Zinc	122	µg/L	5.9	6.0	9.4	9.4	26.9	26.9

Source: Barr 2013f.

Table 5.2.2-31 Comparison of the P10, P50, and P90 Values for Proposed Action and No Action Modeled Concentrations at SW-004a for Selected Key Constituents, Year 25

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Sulfate	NA	mg/L	7.6	7.6	14.0	14.4	19.1	19.1
Arsenic	53	µg/L	1.2	1.2	2.9	2.9	3.7	3.7
Copper	9.5	µg/L	1.4	1.3	2.1	2.2	2.5	2.6
Lead	3.3	µg/L	0.4	0.3	0.5	0.5	0.6	0.6
Nickel	53	µg/L	1.2	1.2	1.7	1.7	2.9	2.9
Zinc	122	µg/L	5.7	5.7	9.4	9.4	26.0	26.0

Source: Barr 2013f.

Table 5.2.2-32 Comparison of the P10, P50, and P90 Values for Proposed Action and No Action Modeled Concentrations at SW-004a for Selected Key Constituents, Year 200

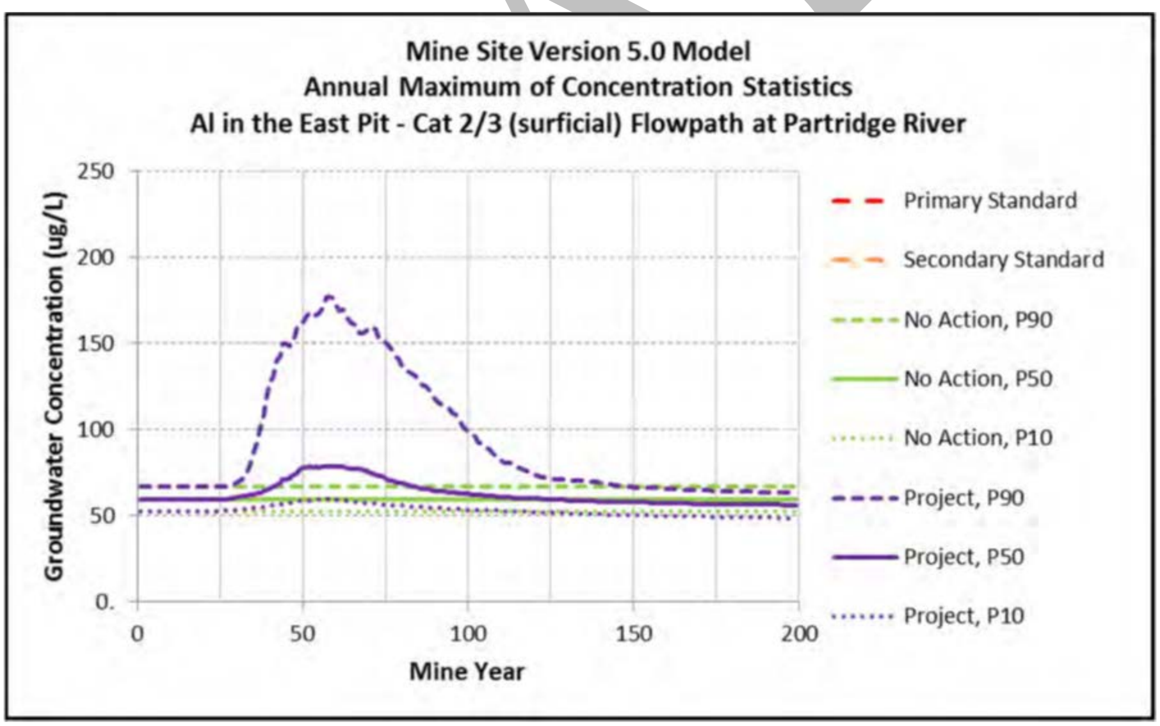
Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Sulfate	NA	mg/L	8.0	8.2	14.0	13.4	19.0	18.9
Arsenic	53	µg/L	1.2	1.6	2.8	3.5	3.8	4.8
Copper	9.5	µg/L	1.4	2.0	2.1	3.7	2.5	4.2
Lead	3.3	µg/L	0.4	0.6	0.5	1.1	0.6	1.3
Nickel	53	µg/L	1.3	5.0	1.7	11.6	2.9	15.0
Zinc	122	µg/L	5.8	11.3	9.5	18.3	26.1	32.6

Source: Barr 2013f.

Aluminum in the Partridge River

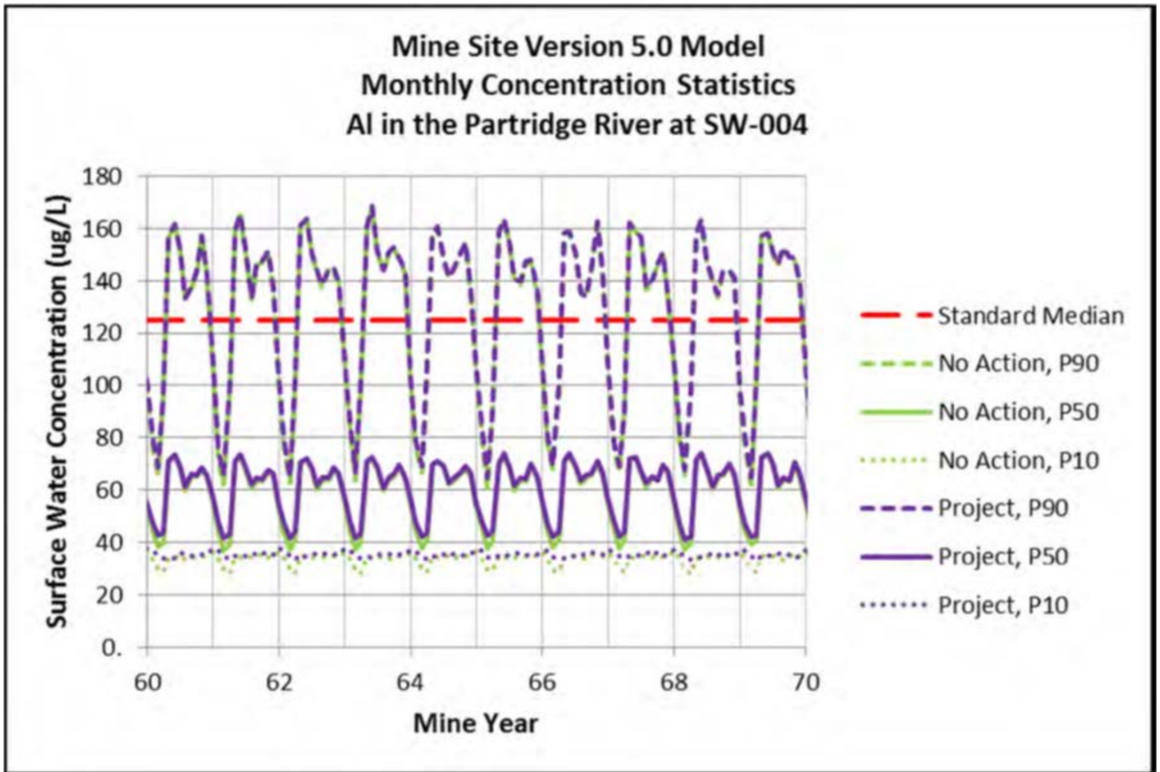
Model results indicate that the maximum P90 concentration of aluminum for the modeled NorthMet Project Proposed Action would exceed the evaluation criterion (125 µg/L) in all seven evaluation locations along the Upper Partridge River. Aluminum maximum P90 values for NorthMet Project Proposed Action conditions range from 165.4 to 173.7 µg/L at the various evaluation locations.

Potential sources of aluminum from the NorthMet Project Proposed Action include the West Pit and the East Pit – Category 2/3 Stockpile. Aluminum concentrations in groundwater flowpaths from the West Pit are consistently below 125 µg/L and actually decrease below NorthMet Project No Action Alternative levels in the long term (Table 5.2.2-29). Groundwater from the East Pit – Category 2/3 Stockpile shows a "pulse" of aluminum concentration that peaks at about 175 µg/L at the Partridge River between years 25 and 125 (Figure 5.2.2-23). Figure 5.2.2-24 shows the modeled, monthly aluminum concentration for years 60 to 70, which captures the pulse shown in Figure 5.2.2-23. Because the groundwater flow rate from the East Pit – Category 2/3 Stockpile is small (41 gpm or 0.09 cfs) compared to normal Partridge River streamflow, it is diluted upon reaching the river at SW-004, the first surface water evaluation location downstream of the contribution of the East Pit – Category 2/3 Stockpile flowpath. As evidenced by the NorthMet Project No Action Alternative and NorthMet Project Proposed Action modeled concentrations being coincident in Figure 5.2.2-24, effects from the NorthMet Project Proposed Action are not discernible.



Source: Barr 2013f.

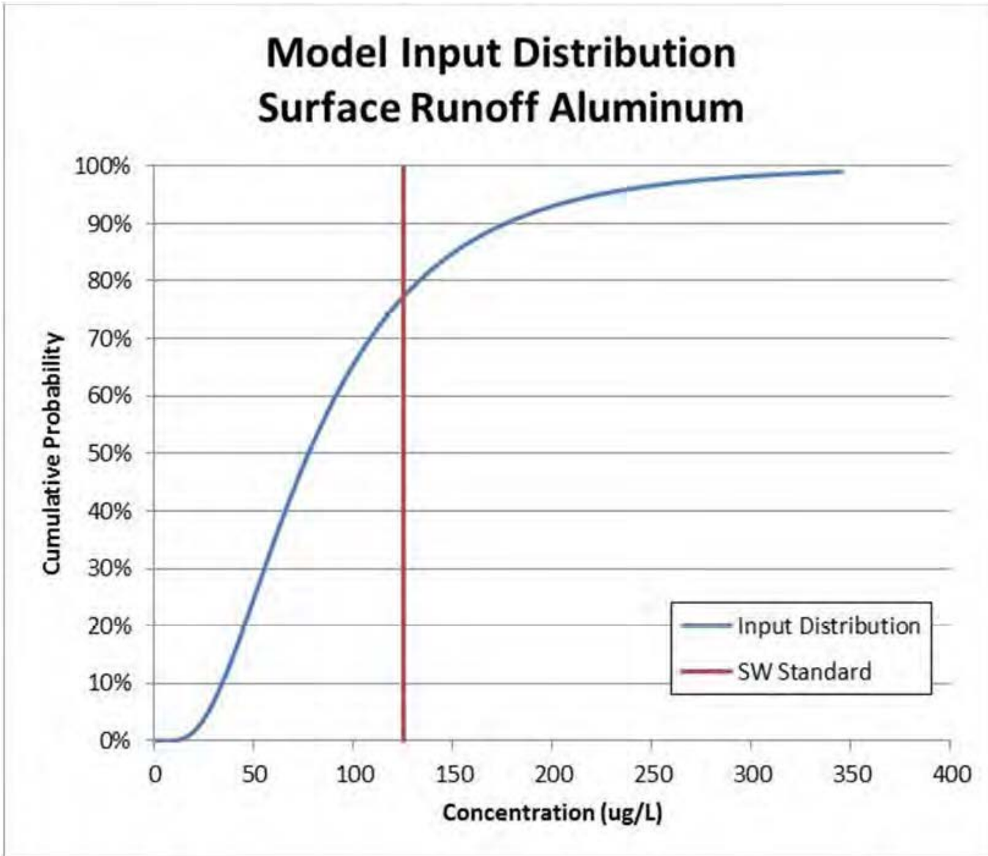
Figure 5.2.2-23 Annual Maximum Aluminum Concentrations Along the Groundwater Flowpath from the East Pit - Category 2/3 Stockpile



Source: Barr 2013f.

Figure 5.2.2-24 Monthly Aluminum Concentrations at SW-004

The modeled exceedances of the aluminum evaluation criteria typically occur between April and November, when surface runoff contributes proportionately more to river flow than groundwater baseflow. Concentrations of aluminum in background surface runoff exceed the evaluation criterion approximately 20 percent of the time, whereas aluminum in groundwater almost never exceeds the evaluation criteria (Figures 5.2.2-25 and 5.2.2-26).



Note: Cumulative probability of non-exceedance

Figure 5.2.2-25 Simulated Distribution of Aluminum Concentrations in Surface Runoff

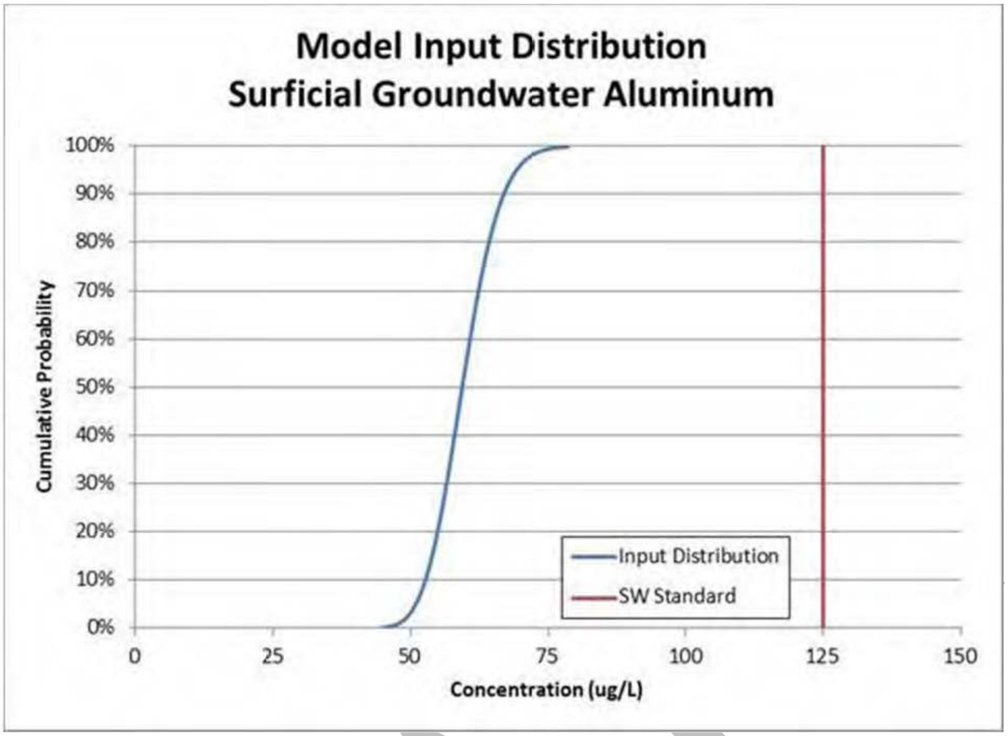


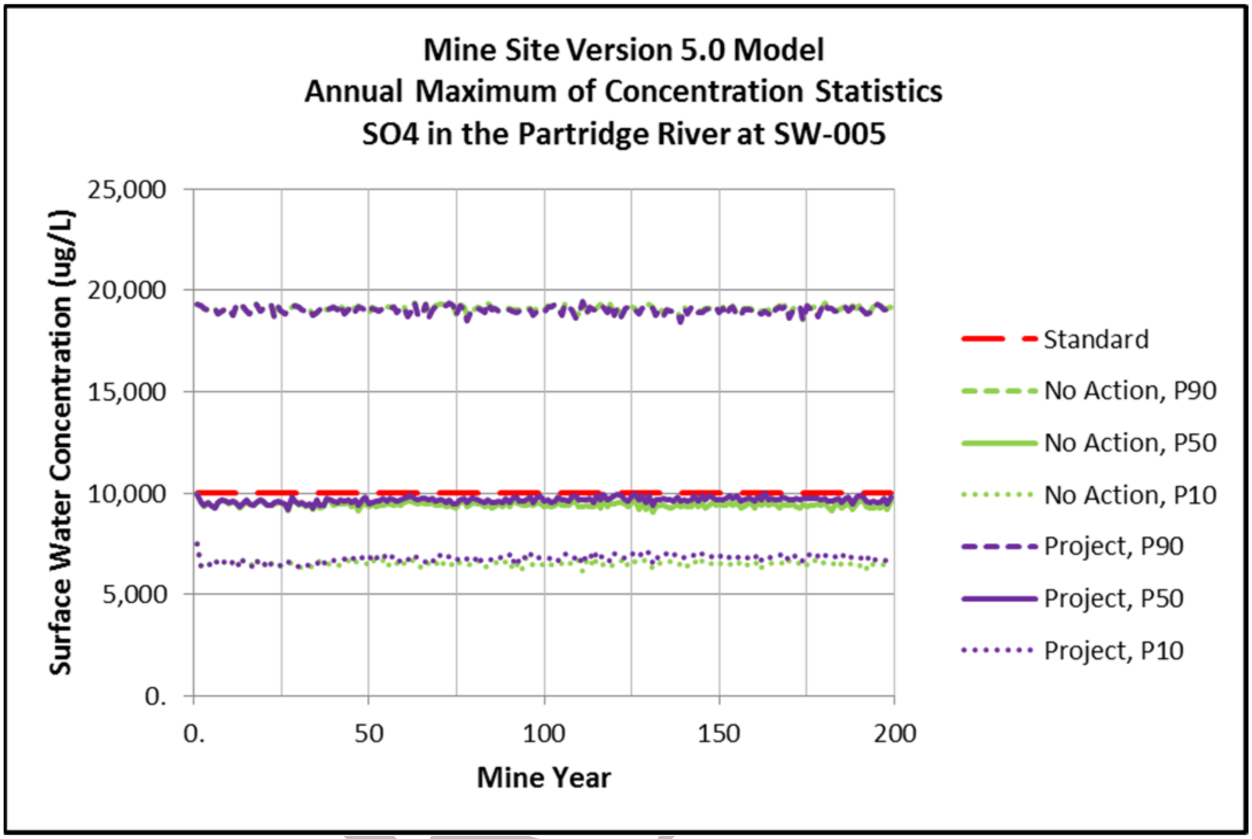
Figure 5.2.2-26 Simulated Distribution of Aluminum Concentrations in Groundwater

As Table 5.2.2-29 indicates above, in comparing the modeled NorthMet Project No Action Alternative concentrations in the Upper Partridge River with the modeled NorthMet Project Proposed Action concentrations, the NorthMet Project Proposed Action would not cause concentrations of aluminum to increase at evaluation locations and would actually cause aluminum concentrations to decrease slightly (from a maximum P90 concentration of 173.9 µg/L for the NorthMet Project No Action Alternative to 173.7 µg/L for the NorthMet Project Proposed Action) due to changes in watershed configuration and the release of groundwater from the West Pit with relatively lower aluminum concentrations.

Although aluminum concentrations in the Upper Partridge River would exceed evaluation criteria, the concentrations are predicted to be about the same as or slightly less than they would be under the NorthMet Project No Action Alternative. Therefore, it is predicted that the NorthMet Project Proposed Action would not have an adverse effect on aluminum concentrations in the Upper Partridge River. Moreover, the modeled exceedances are attributable to background surface runoff, which is naturally high in aluminum.

<u>*Sulfate in the Partridge River*</u>

The MPCA has determined that the lower portion of the Partridge River at SW-005 is considered a water used for the production of wild rice, and it is therefore subject to the 10 mg/L sulfate evaluation criterion. As Table 5.2.2-29 above indicates, the maximum P90 sulfate concentrations at SW-005 is predicted to be 19.4 mg/L, which would exceed the wild rice sulfate evaluation criteria. The modeled NorthMet Project No Action Alternative also predicts similar maximum P90 sulfate concentrations (Figure 5.2.2-27). However, since the 10 mg/L standard applies at SW-005, a more robust discussion of sulfate modeling results at that location is provided to better define the magnitude and timing of NorthMet Project Proposed Action effects. It should be noted, however, that the average (P50) sulfate concentrations at SW-005 for the NorthMet Project Proposed Action for the 200-year modeling period would generally be slightly less than the 10 mg/L standard, and nearly identical to the NorthMet Project No Action Alternative concentrations.



Source: Barr 2013f.

Figure 5.2.2-27 Maximum Annual Sulfate Concentration Percentiles at SW-005

The NorthMet Project Proposed Action would have negligible effect on sulfate concentrations at SW-005 during mine operations and reclamation (years 0 to 40), relative to the NorthMet Project No Action Alternative, as there would be no discharge of WWTF effluent until year 40 and the contributions from groundwater flowpaths in most cases would not yet have reached the Partridge River.

The NorthMet Project Proposed Action would have greater potential to affect sulfate concentrations at SW-005 during closure for the following reasons:

- increased sulfate contributions to the Partridge River from the East Pit – Category 2/3 Stockpile surficial aquifer flowpath, which is predicted to range from 10 to 20 mg/L and to peak in terms of flow at approximately year 125;
- increased sulfate contributions to the Partridge River from the Overburden Storage and Laydown Area surficial aquifer flowpath, which is predicted to range from 10 to 20 mg/L and to peak in terms of flow at between approximately years 50 to 100; and

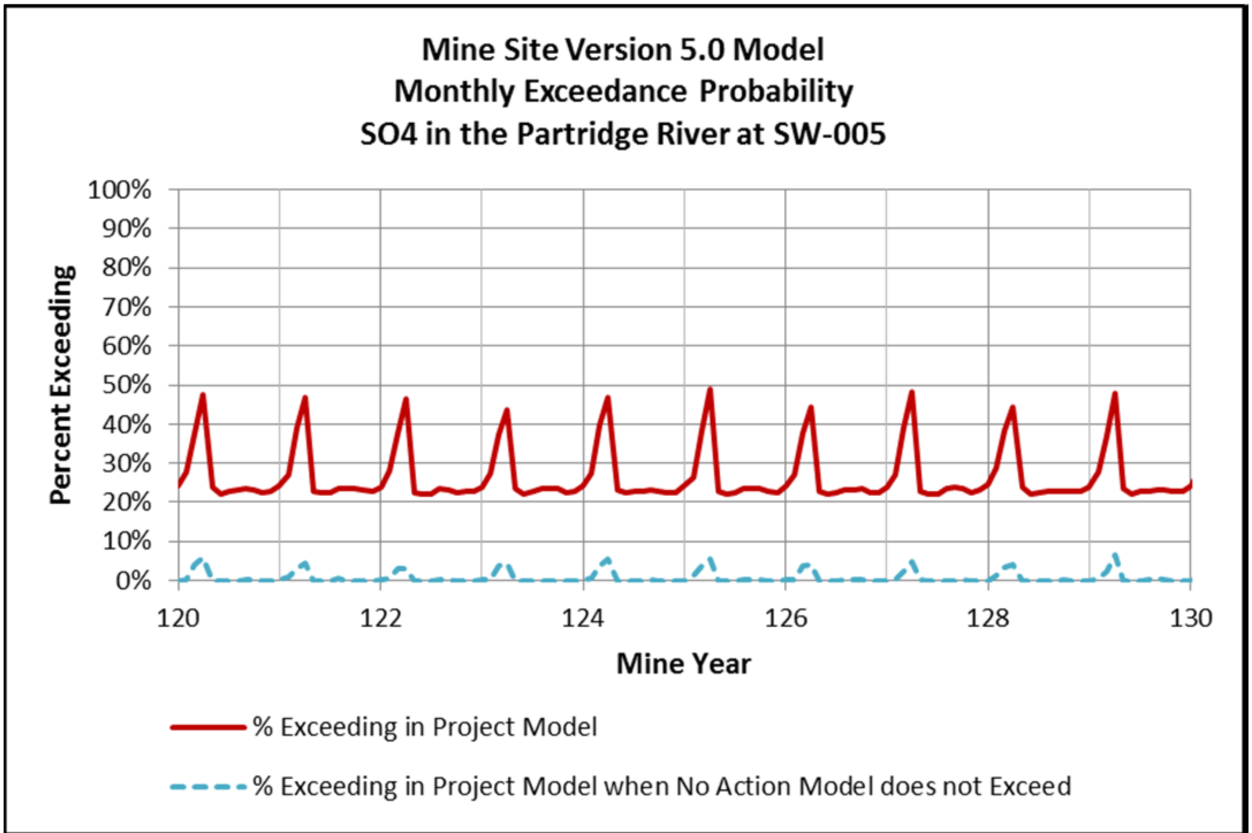
- increased sulfate concentrations to the Partridge River from the West Pit surficial aquifer flowpath, which is predicted to range from 10 to 35 mg/L and to peak at approximately year 125.

Collectively these three sources of sulfate only total about 0.17 cfs (78 gpm) of flow, so represent only a small percentage (approximately 0.2 percent) of the average flow in the Partridge River (about 78 cfs at SW-005). These sources would have a proportionally greater effect on flow (and sulfate loadings) during the winter when low flows (average 30-day low flow of 4.9 cfs at SW-005) typically occur (i.e., 0.17 cfs represents 3.5 percent of the average 30-day low flow).

Other sources of sulfate loadings generally have sufficiently low concentrations that they tend to dilute loadings from these sources. For example, surface runoff is expected to only have a median sulfate concentration of 3.6 mg/L, and the WWTF, which would begin discharging approximately 300 gpm to the Partridge River upstream of SW-005 in year 40, would have a design effluent concentration of 9 mg/L sulfate. The contributions from the three groundwater sources to SW-005 during closure, especially around year 125, are quantified below.

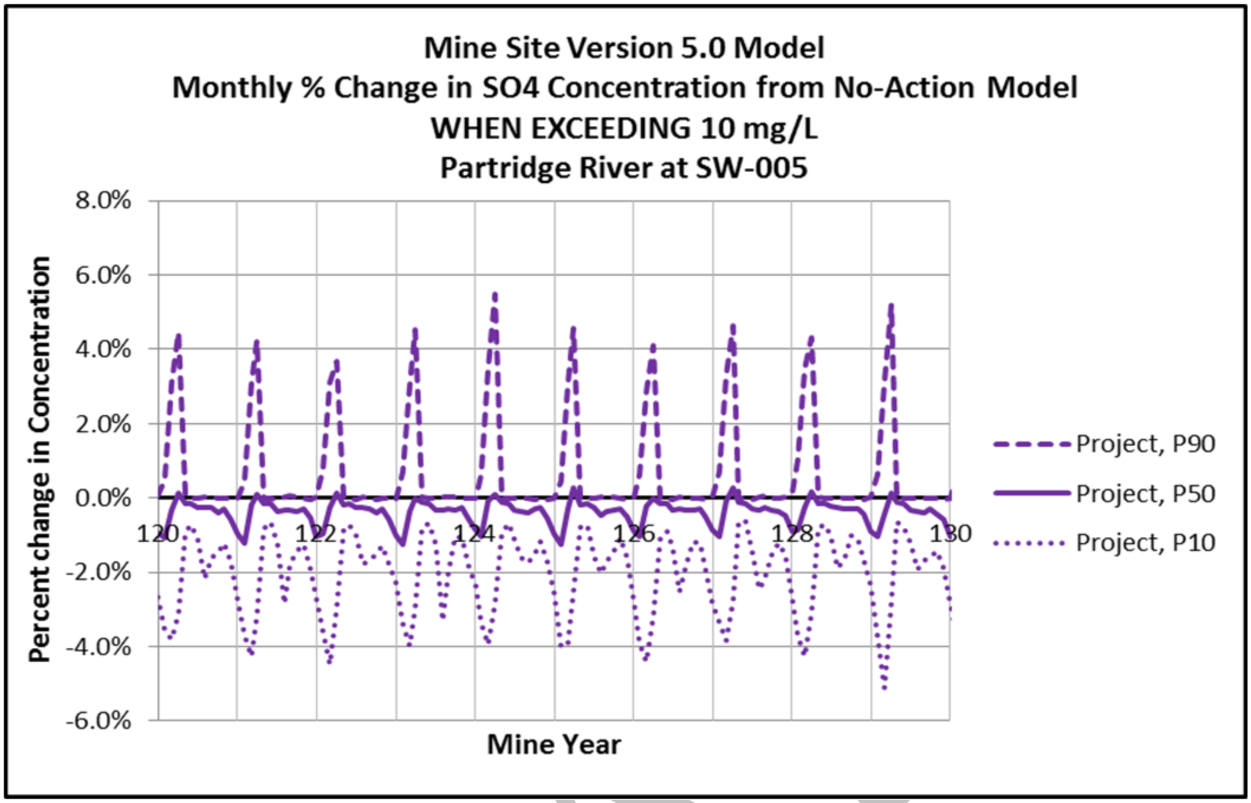
- NorthMet Project Proposed Action effects on the frequency of sulfate exceedances of the evaluation criteria – Under the NorthMet Project No Action Alternative, there is between a 23 to 45 percent likelihood that the sulfate concentrations at SW-005 would exceed the 10 mg/L evaluation criteria in any given month. As illustrated in Figure 5.2.2-28, the NorthMet Project Proposed Action would result in a maximum of a 6.6 percent increase in the probability that sulfate concentrations would exceed the evaluation criteria for months where NorthMet Project No Action Alternative would not result in an exceedance. These exceedances, however, would be almost exclusively limited to the low-flow winter months.

- NorthMet Project Proposed Action effects on increasing the magnitude of an exceedance – During months when the modeled sulfate concentration at SW-005 exceeds the 10 mg/L evaluation criteria, Figure 5.2.2-29 illustrates the modeled sulfate concentrations for the NorthMet Project Proposed Action in terms of percent change from the NorthMet Project No Action Alternative during years 120 to 130. As this figure demonstrates, sulfate concentrations in closure may increase or decrease on a monthly basis relative to the NorthMet Project No Action Alternative. However, the NorthMet Project Proposed Action is more likely to decrease concentrations than increase concentrations (as evidenced by the P50 line being negative [less than the NorthMet Project No Action Alternative]) for most months. As discussed above, the sulfate concentration is most likely to increase due to the NorthMet Project Proposed Action during winter low-flow periods with a 90 percent probability that the increase would be less than a maximum of 5.6 percent, which equates to approximately 1.1 mg/L (5.6 percent times 19.2 mg/L [i.e., max P90 sulfate concentration between years 120 and 130 at SW-005]). During the remainder of the year, however, the NorthMet Project Proposed Action has a low probability of contributing to an increase in concentration; in many months there is a 90 percent probability that concentrations would decrease rather than increase.



Source: Barr 2013f.

Figure 5.2.2-28 Likelihood that Monthly Sulfate Concentration at SW-005 Exceeds 10 mg/L, Mine Years 120 to 130



Source: Barr 2013f.

Figure 5.2.2-29 Percent Change in Sulfate Concentration when Exceeding 10 mg/L, Mine Years 120 to 130

Therefore, the likelihood of the NorthMet Project Proposed Action causing an exceedance of the evaluation criteria that would not occur without the NorthMet Project Proposed Action would be less than 10 percent. Further, the effect of the NorthMet Project Proposed Action on sulfate concentrations at SW-005 during months when exceedances of the 10 mg/L evaluation criteria would occur anyway would range from a maximum increase of 5.6 percent (limited to during low-flow winter months) to a likely maximum decrease of about 5 percent during the remainder of the year.

Throughout the mine life, there would be ongoing monitoring of groundwater quality downgradient of mine features. If future modeling, informed by the results of the groundwater monitoring, predicted exceedances of the applicable evaluation criteria for sulfate, then contingency mitigation could be implemented and adapted as necessary to decrease NorthMet Project Proposed Action effects on the Partridge River prior to an actual effect occurring (Barr 2013g).

It should be noted that the GoldSim model assumes the WWTF effluent only attains a sulfate concentration of 9 mg/L. Recent pilot testing of the proposed RO unit resulted in average sulfate removal rates of 99.8 percent with an average and maximum sulfate concentrations observed in the effluent of 3.7 and 6.9 mg/L, respectively, for the blended (RO and vibratory shear enhanced processing) streams, which is below the 9 mg/L value assumed for modeling purposes (Barr 2013g). Given that the WWTF would have an annual average discharge of approximately 300 gpm, as compared to about 67 gpm from the three groundwater sources of sulfate, a small decrease in the assumed sulfate concentration in the WWTF effluent would more than offset the increased loading from the three groundwater sources. Therefore, there clearly appears to be effective contingency mitigation measures available if monitoring indicates a need.

Effects on Surface Water Quality in the Upper Partridge River Tributary Streams

This section discusses the effects on surface water quality in the four Upper Partridge River tributary streams: West Pit Outlet, Wetlegs Creek, Longnose Creek, and Wyman Creek. Surface water quality in these streams would primarily be affected by the NorthMet Project Proposed Action by ore spillage during rail transport from the Mine Site to the processing plant.

It is estimated that 55.7 kg ore/m^2 track could spill from rail cars within the first 1,000 meters of the Transportation and Utility Corridor over the 20-year life of the NorthMet Project Proposed Action. This is equivalent to 1.25 inches of spilled material over a 2,000 m^2 area. Rainfall contacting the spilled ore has the potential to release contaminants, but the relatively small volume of material and dilution from other sources are expected to result in surface water quality meeting the evaluation criteria (PolyMet 2013l).

During closure, there may be residual effects on surface water quality from the spilled ore, although the small quantity of expected spilled material would become depleted of sulfide materials rapidly compared to the much larger waste rock stockpiles (PolyMet 2013l).

In order to guard against possible adverse effects from spilled ore, monitoring and mitigation activities would be developed. Water quality modeling is recommended downgradient from the rail line on the tributary streams to check for any deteriorations of water quality over time from ore spillage, and, if detected, adaptive water management measures would be implemented.

Effects on Surface Water Quality in Colby Lake and Whitewater Reservoir

The GoldSim modeling indicates that the NorthMet Project Proposed Action would meet all evaluation criteria at the P90 level, except for aluminum, iron, and manganese, as indicated in Table 5.2.2-33. These three solutes with apparent exceedances in Colby Lake, as well as arsenic, because of the more stringent water quality evaluation criteria for drinking water supplies, are discussed below.

Table 5.2.2-33 Maximum Modeled Monthly P90 Surface Water Concentrations for the Colby Lake

Parameter	Colby Lake Evaluation Criteria	Units	No-Action Alternative (Max P90 Value)	Proposed Action (Max P90 Value)	% Change from No Action
General					
Alkalinity	NA	mg/L	128.3	128.1	NA
Calcium	NA	mg/L	30.1	30.1	NA
Chloride	230	mg/L	22.7	22.7	0%
Fluoride	4	mg/L	0.19	0.19	0%
Hardness	500	mg/L	118.0	117.9	-0.1%
Magnesium	NA	mg/L	13.7	13.7	0%
Potassium	NA	mg/L	3.60	3.6	0%
Sodium	NA	mg/L	18.3	18.3	0%
Sulfate	250	mg/L	19.4	19.4	0%
Metals Total					
Aluminum	125	µg/L	**173.6**	**173.0**	-0.3%
Antimony	5.5	µg/L	1.65	1.69	2.4%
Arsenic	2	µg/L	0.65	0.90	38.5%
Barium	2000	µg/L	12.7	13.3	4.7%
Beryllium	4	µg/L	0.10	0.11	10%
Boron	500	µg/L	178.9	178.6	-0.2%
Cadmium	5[1]	µg/L	0.12	0.15	25%
Chromium	11	µg/L	1.86	1.87	0.5%
Cobalt	2.8	µg/L	0.56	0.68	21.4%
Copper	4.56[1]	µg/L	2.09	2.25	7.7%
Iron	300	µg/L	**2,590**	**2,575**	-0.6%
Lead	1.08[1]	µg/L	0.31	0.38	22.6%
Manganese	50	µg/L	**240.6**	**237.7**	1.2%
Nickel	25.6[1]	µg/L	2.98	3.94	32.2%
Selenium	5	µg/L	0.61	0.63	3.3%
Silver	1	µg/L	0.12	0.12	0%
Thallium	0.28	µg/L	0.05	0.05	0%
Vanadium	NA	µg/L	5.41	5.43	0.4%
Zinc	58.1[1]	µg/L	27.5	27.6	0.4%

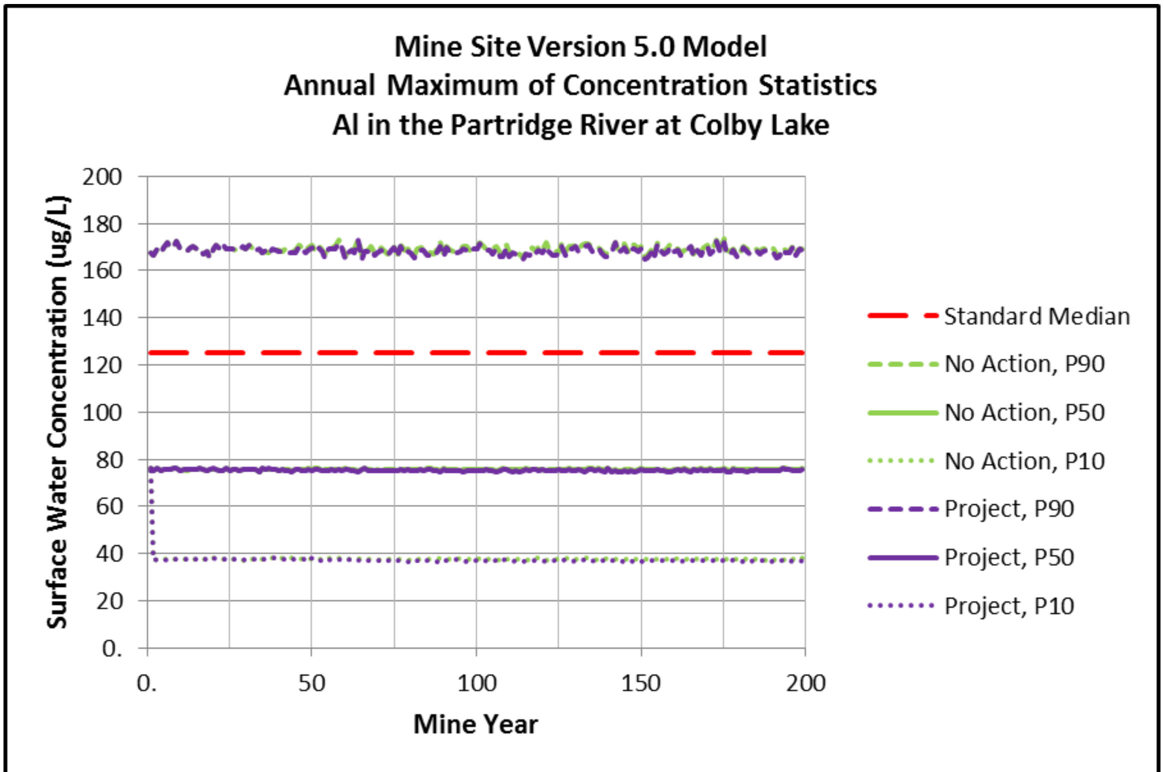
Source: Barr 2013f.

Note: Bold font indicated an exceedance of the evaluation criteria.
[1] Evaluation criterion is hardness-dependent and estimated using hardness at maximum solute P90 concentration.

Table 5.2.2-33 above shows the percent change from the modeled No Action Alternative. The percent change can appear quite large, but the absolute change is quite small, especially when compared with the evaluation criteria. A good example is nickel, which has a maximum P90 value that increases 32.2 percent, but the absolute increase is less than 1 µg/L, and the NorthMet Project Proposed Action maximum modeled P90 value (3.94 µg/L) is still well below the evaluation criteria (25.6 µg/L).

Aluminum

Model results indicate that the maximum P90 concentration of aluminum (173 µg/L) exceeds the evaluation criteria (125 µg/L) in Colby Lake, just as it is predicted to along most of the Partridge River (Figure 5.2.2-30).



Source: Barr 2013f.

Figure 5.2.2-30 Colby Lake Annual Maximum Aluminum Concentrations

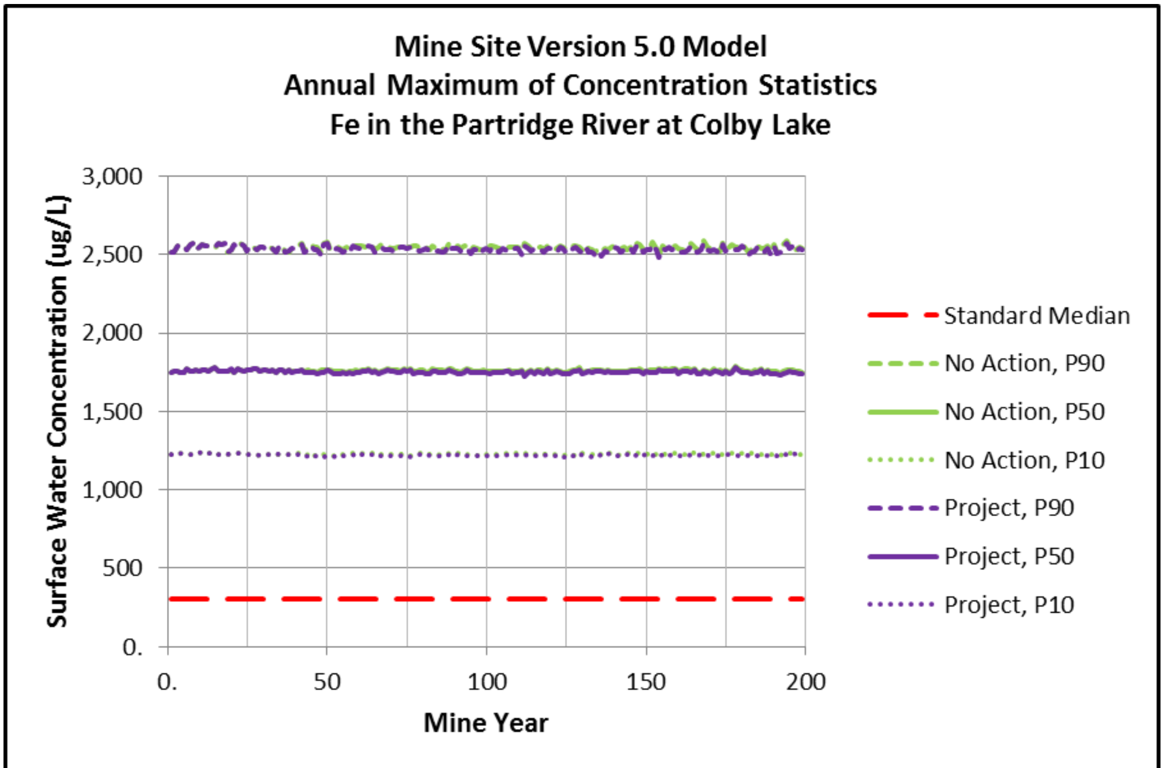
The exceedances of the aluminum evaluation criterion typically occur between April and November, when surface runoff contributes proportionately more to river flow than groundwater baseflow. Concentrations of aluminum in background surface runoff exceed the water quality standard approximately 20 percent of the time, whereas aluminum in groundwater almost never exceeds the evaluation criteria (see Figures 5.2.2-25 and 5.2.2-26).

As Table 5.2.2-33 and Figure 5.2.2-30 indicate above, in comparing the *modeled* NorthMet Project No Action Alternative concentrations in Colby Lake with the *modeled* NorthMet Project Proposed Action concentrations, the NorthMet Project Proposed Action would not cause concentrations of aluminum to increase at evaluation locations and would actually cause aluminum concentrations to decrease slightly (from a maximum P90 concentration of 173.6 µg/L for the NorthMet Project No Action Alternative to 170.0 µg/L for the NorthMet Project Proposed Action) due to changes in watershed configuration and the release of groundwater from the West Pit with relatively lower aluminum concentrations.

Further, aluminum has not been an issue for the City of Hoyt Lakes. 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.

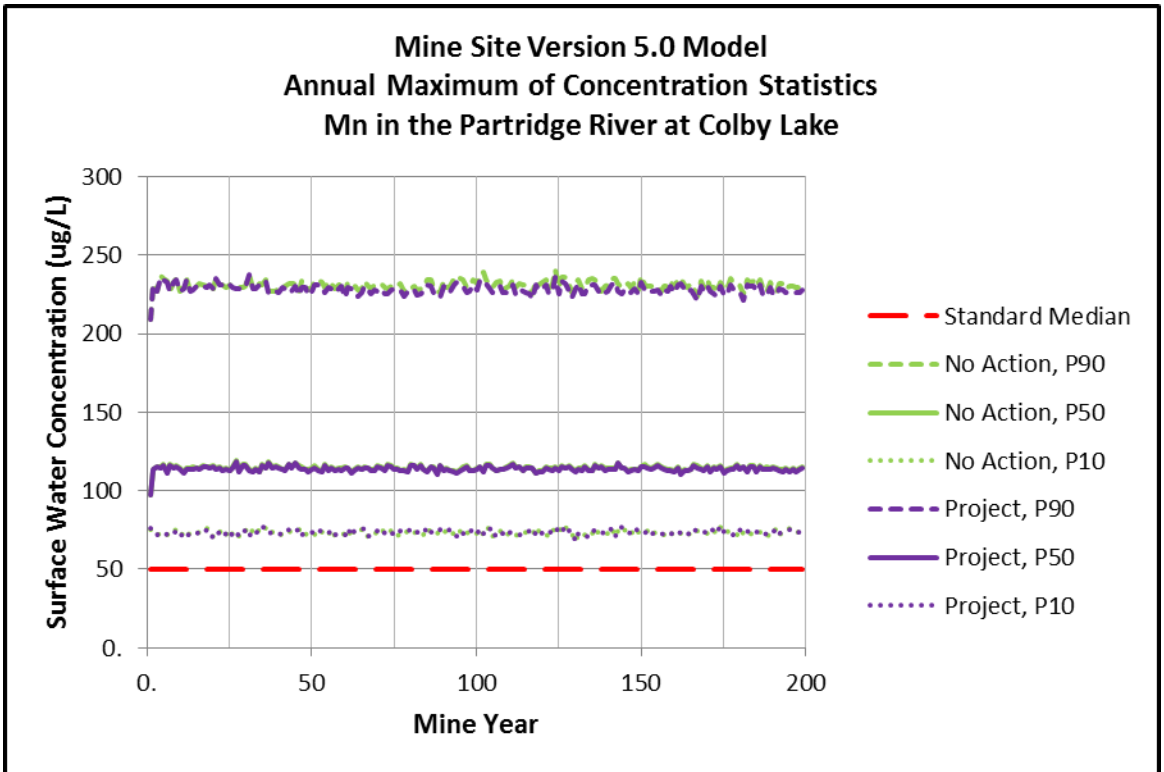
Iron and Manganese

Since Colby Lake is used as a drinking water source by the City of Hoyt Lakes, the USEPA sMCL evaluation criteria apply. The model results indicate that iron concentrations exceed the 300 µg/L evaluation criterion and that manganese concentrations exceed the 50 µg/L evaluation criterion, as shown in Figures 5.2.2-31 and 5.2.2-32 below.



Source: Barr 2013f.

Figure 5.2.2-31 Colby Lake Annual Maximum Iron Concentration



Source: Barr 2013f.

Figure 5.2.2-32 Colby Lake Annual Maximum Manganese Concentrations

Actual *monitored* background iron and manganese concentrations in Colby Lake, however, are naturally high and exceed their respective evaluation criteria. Over 90 percent of the background iron samples exceed its evaluation criteria (300 µg/L) and approximately 80 percent of the background manganese samples exceed its evaluation criteria (50 µg/L).

In comparing the *modeled* NorthMet Project No Action Alternative concentrations in Colby Lake with the *modeled* NorthMet Project Proposed Action concentrations, it appears that the NorthMet Project Proposed Action causes a slight decrease in the long-term P90 concentrations for both iron and manganese due to changes in the watershed area, the lower iron concentration effluent from the WWTF (design maximum effluent concentration of 300 µg/L for iron and 50 µg/L for manganese), and the lower long-term seepage concentration from the West Pit lake (Figures 5.2.2-33 and 5.2.2-34).

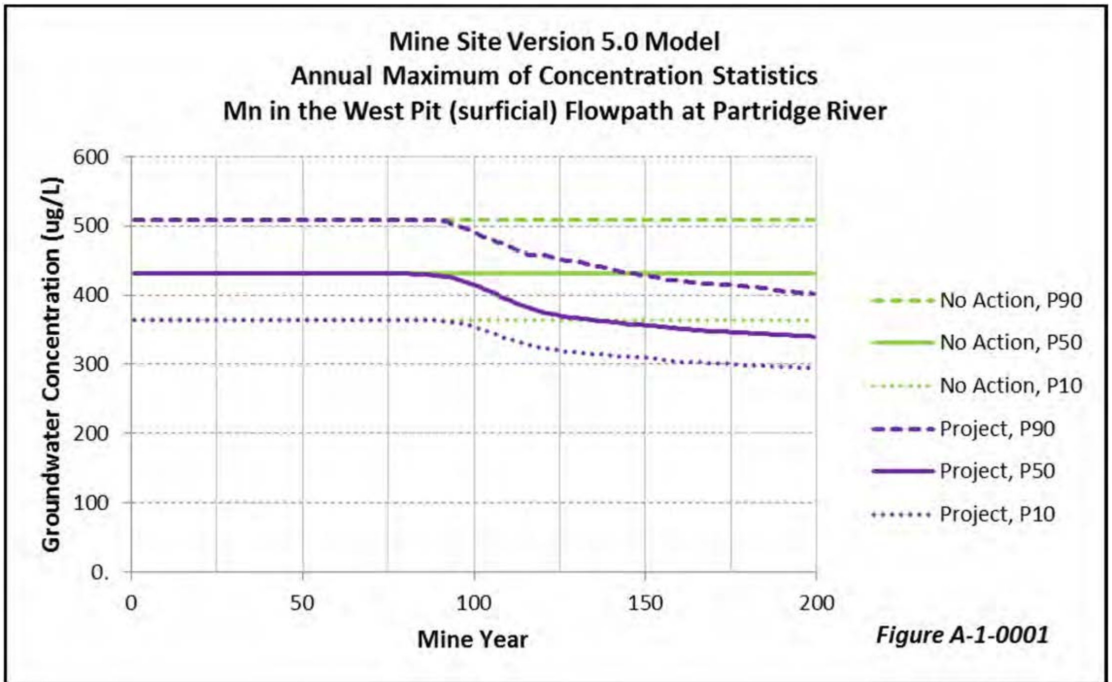


Figure 5.2.2-33 Annual Maximum Manganese Concentration in the West Pit Flowpath

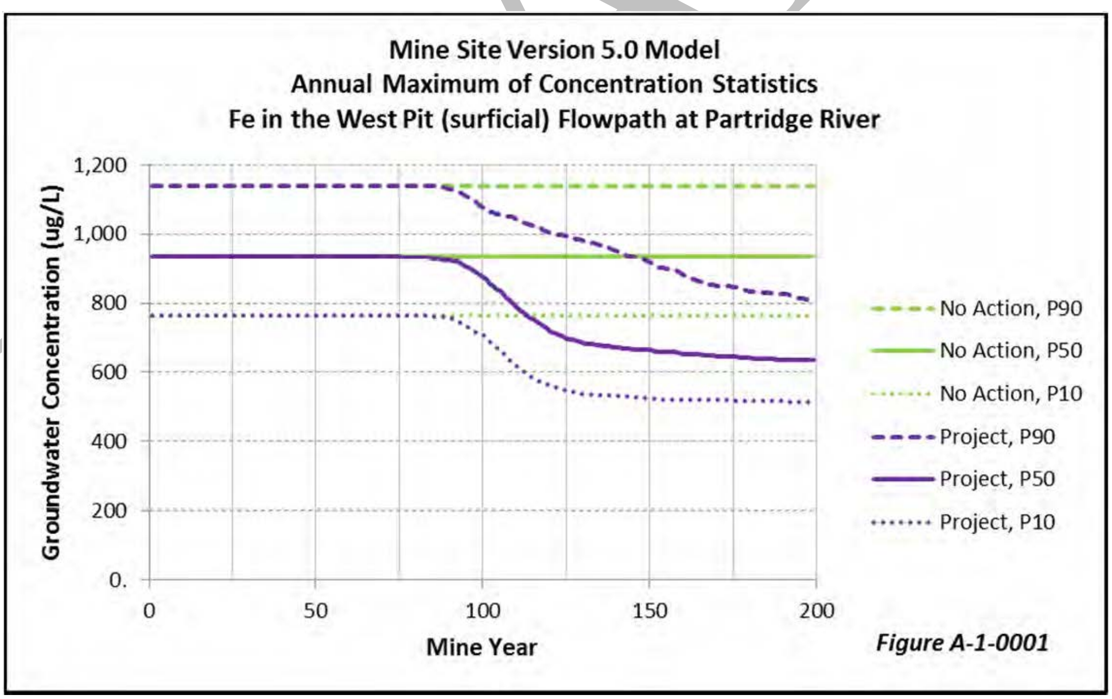
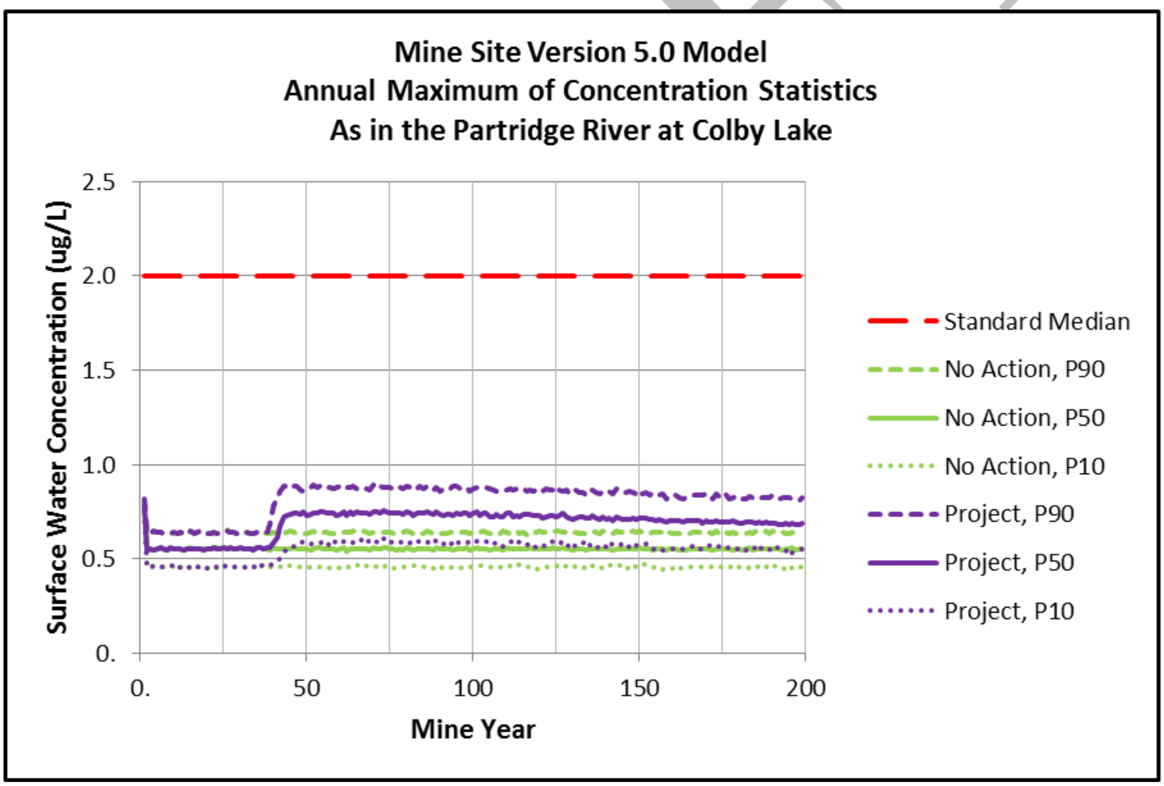


Figure 5.2.2-34 Annual Maximum Iron Concentration in the West Pit Flowpath

Therefore, although the NorthMet Project Proposed Action is predicted to result in exceedances of the iron and manganese evaluation criteria, the concentrations are predicted to be no worse, and over the long term predicted to be slightly lower than under the NorthMet Project No Action Alternative. Further, iron and manganese 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 (Nelson, Pers. Comm., October 1, 2009).

Arsenic

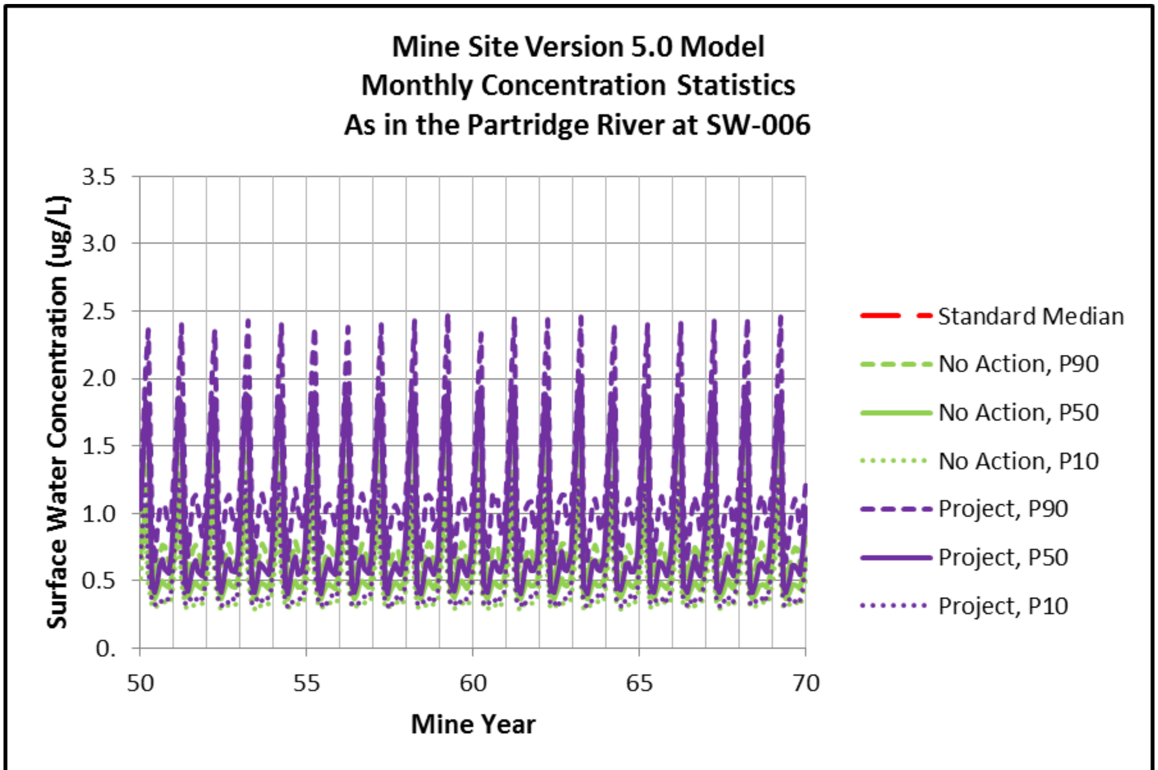
The water quality evaluation criteria for arsenic is 52 µg/L in the Partridge River, but drops to only 2 µg/L in Colby Lake because of its use as a drinking water source by the City of Hoyt Lakes. As Figure 5.2.2-35 indicates, P90 annual maximum arsenic concentrations are predicted to be well below the evaluation criteria of 2.0 µg/L.



Source: Barr 2013f.

Figure 5.2.2-35 Colby Lake Annual Maximum Arsenic Concentrations

However, the predicted arsenic concentrations at the nearest evaluation location (SW-006) consistently show annual maximum P90 concentrations above 2 µg/L from year 40 onwards (i.e., when the West Pit begins to overflow), with a predicted high concentration of 2.48 µg/L in year 59 (Figure 5.2.2-36). These “elevated” concentrations at SW-006 (relative to the Colby Lake evaluation criteria) could raise concern for the potential of exceedances of the arsenic evaluation criteria in Colby Lake.



Source: Barr 2013f.

Figure 5.2.2-36 Partridge River SW-006 Annual Maximum Arsenic Concentrations

Closer review of the monthly predictions for arsenic concentrations at SW-006, however, show that these elevated concentrations above 2 µg/L only occur during the late winter when Partridge River flows are low (i.e., average flow at SW-006 in February and March of approximately 19 cfs) and never occur for more than two consecutive months. Given Colby Lake has a volume of approximately 5,000 acre ft, the residence time of these elevated arsenic concentrations during late winter flows would be over four months. Therefore, these low flow/elevated concentrations of arsenic essentially get blended with high flow/lower concentrations of arsenic such that arsenic concentrations in Colby Lake are not predicted to exceed the 2 µg/L evaluation criteria at the 90th-percentile probability.

Furthermore, the primary NorthMet Project Proposed Action source of arsenic load to Colby Lake is from the WWTF. PolyMet has assumed that effluent from the WWTF would have an arsenic concentration of 10 µg/L. In fact, the pilot testing of the WWTP, using the same RO technology and greensand filter pretreatment as proposed for the WWTF with influent arsenic concentrations similar to that expected as the West Pit, resulted in effluent arsenic concentrations of less than 1 µg/L (Barr 2013g). Therefore, the predicted arsenic load to the Partridge River from the Mine Site is likely conservatively high, since pilot testing suggests that actual WWTF treatment performance could result in arsenic concentrations that would be as much as 90 percent lower than assumed in the GoldSim modeling.

Whitewater Reservoir

The NorthMet Project Proposed Action should have negligible effects on water quality in Whitewater Reservoir because only high Partridge River flows would be diverted into the reservoir from Colby Lake, which would coincide with the periods when any contaminants from the NorthMet Project Proposed Action would be diluted and because the water quality of Colby Lake is predicted to meet water quality standards, prior to dilution, except for the three parameters (i.e., aluminum, iron, and manganese) that are explained above.

Water Quality Effects in the Lower Partridge River

The NorthMet Project Proposed Action would not result in any new surface water discharges (other than stormwater runoff from the processing plant area) or groundwater seepage that would affect the water quality of the Lower Partridge River that are not already reflected in predicted upstream water quality. Although not specifically modeled, water quality in the Lower Partridge River would be expected to reflect water quality conditions as water flows out of Colby Lake, which, as discussed above, is predicted under the NorthMet Project Proposed Action to meet all water quality evaluation criteria other than for aluminum, iron, and manganese, which is attributable to natural background conditions. The contaminant load in flow from Colby Lake attributable to the NorthMet Project Proposed Action would be further diluted downstream as the watershed area increases, and therefore would not be culpable for any exceedances of water quality evaluation criteria.

These contaminant loads from the NorthMet Project Proposed Action, however, could contribute to cumulative effects in combination with contaminant loading from other projects. A review of the available surface water quality monitoring data for the Lower Partridge River indicates that the water quality of the Lower Partridge River is generally similar to that of Colby Lake except for significantly higher sulfate values (i.e., mean of 33.8 mg/L at Colby Lake versus 164 mg/L in the Lower Partridge River) at County Road 110, which is significantly above the 10 mg/L evaluation criteria that is applicable to waters supporting the production of wild rice. The potential for the NorthMet Project Proposed Action to contribute to cumulative effects on sulfate concentrations in the Lower Partridge River, and further downstream in the St. Louis River, is discussed in Section 6.2.3.3.

NorthMet Project Proposed Action Contaminant Contribution Over Time

As discussed above, the NorthMet Project Proposed Action is predicted to meet all groundwater and surface water quality evaluation criteria at all evaluation locations for all mine phases (operations, reclamation, and closure). There is value, however, in understanding how the NorthMet Project Proposed Action contributes to the contaminant load in the Partridge River over time.

The NorthMet Project Proposed Action essentially contributes contaminants to the Partridge River from seven sources: the six groundwater sources (Overburden Storage and Laydown Area, Ore Surge Pile, Category 2/3 Stockpile, WWTF equalization basins, East Pit, and the West Pit) and the WWTF effluent discharge. As Table 5.2.2-34 shows, four of these sources would be temporary during operations only (Overburden Storage and Laydown Area, Ore Surge Pile, Category 2/3 Stockpile, and WWTF equalization basins); their peak contributions occur within the 200-year model period and future loadings would not occur as the source would be removed.

Table 5.2.2-34 Estimated Travel Times for Contaminant Plumes to Reach the Partridge River

Source	Flow Rate from Source into Surficial GW Flowpath (gpm)	Time Period that Source is Active (Mine Year)	Time for Peak Loading at Partridge River (Mine Year)
Overburden Storage and Laydown Area	14.0	0 to 21	70(1)
Ore Surge Pile	0.0012	0 to 21	165
Category 2/3 Stockpile	0.019	0 to 21	55
WWTF leakage	0.013	0 to 37	175
East Pit	3.75	24 onward	155
West Pit	6.1	40 onward	160
WWTF discharge(2)	285	40 onward	40 onward

1 For most constituents, source causes a concentration *decrease* in the flowpath; reported time is for *minimum* river loading.
2 Discharge of WWTF effluent directly into the river.

For purposes of this SDEIS, the WWTF is considered a permanent facility and would be discharging treated effluent for perpetuity. It should be noted, however, that the water quality of both pits would be expected to improve over time as the pits would be flooded, thereby effectively eliminating oxidation of the pit walls, the primary source of contaminants, except for the upper few feet where water levels may fluctuate. Figures 5.2.2-37, 5.2.2-38, and 5.2.2-39 show how the water quality of the West Pit is expected to improve over time for three representative solutes: cobalt, nickel, and sulfate. These predicted improvements in water quality suggest that the WWTF may not need to operate permanently, but that at some point more passive, non-mechanical treatment measures may be sufficient to meet water quality standards.

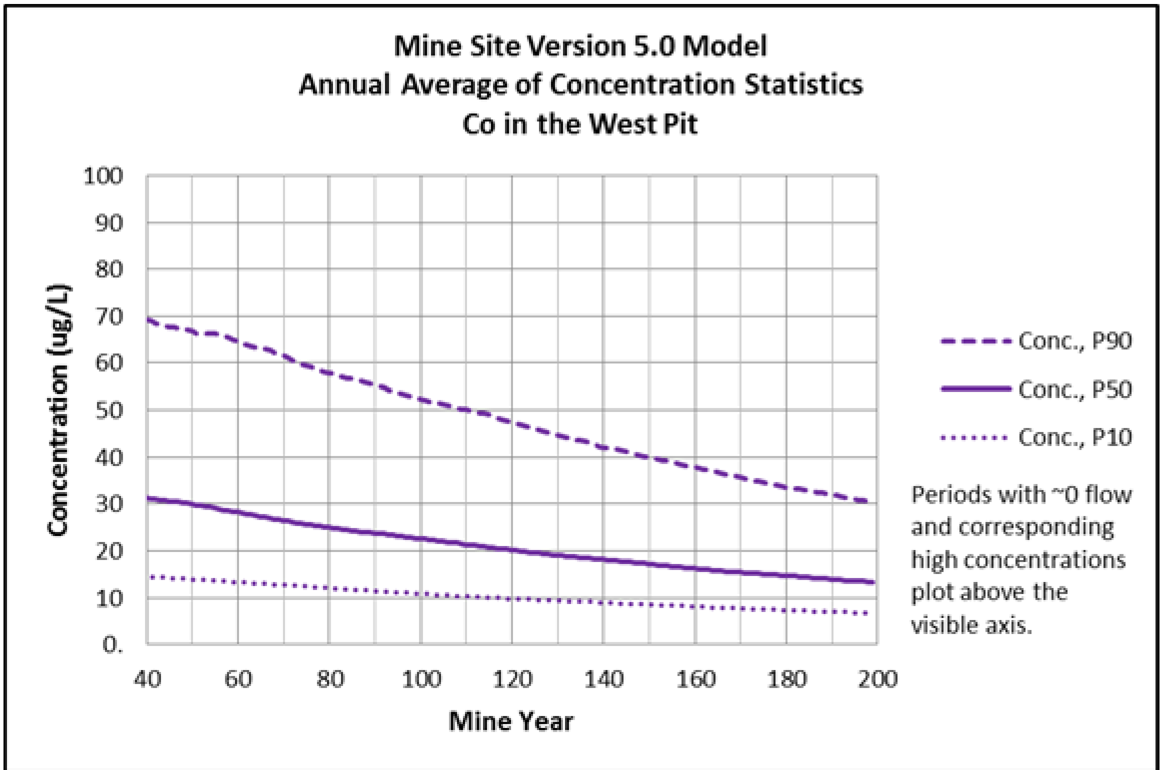


Figure 5.2.2-37 Average P90 Concentration of Cobalt in the West Pit over 200 Years

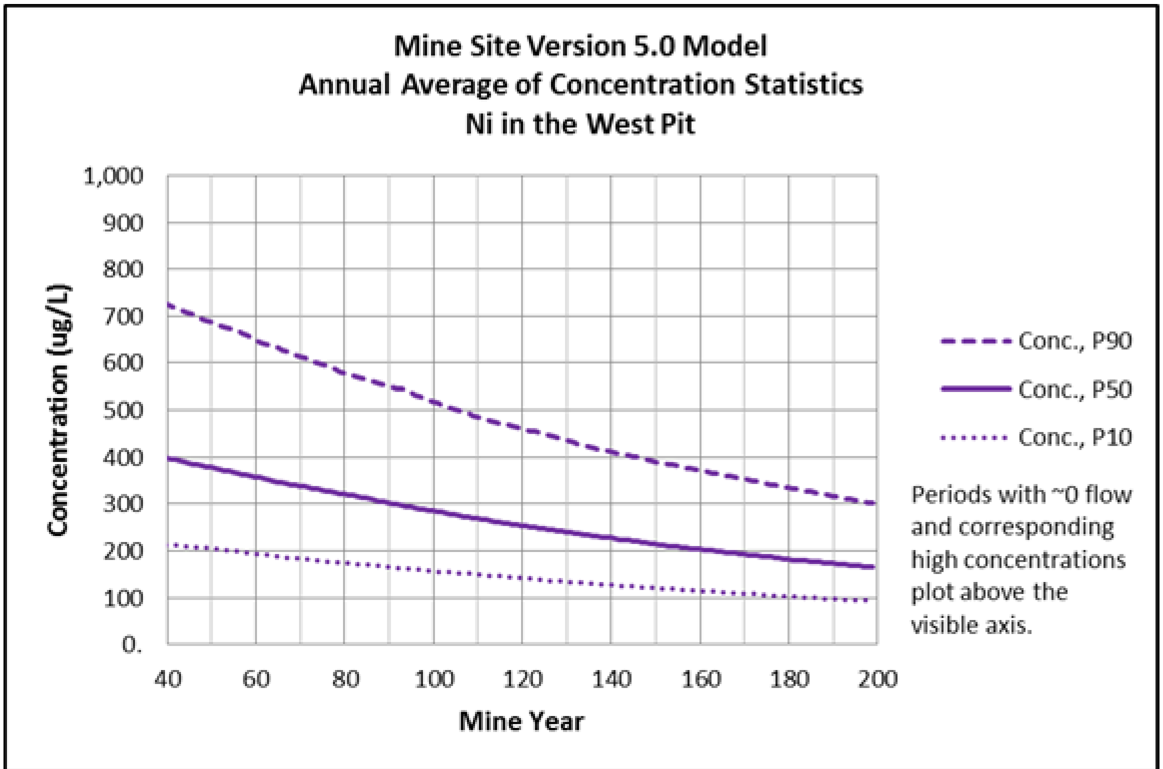


Figure 5.2.2-38 Average P90 Concentration of Nickel in the West Pit over 200 Years

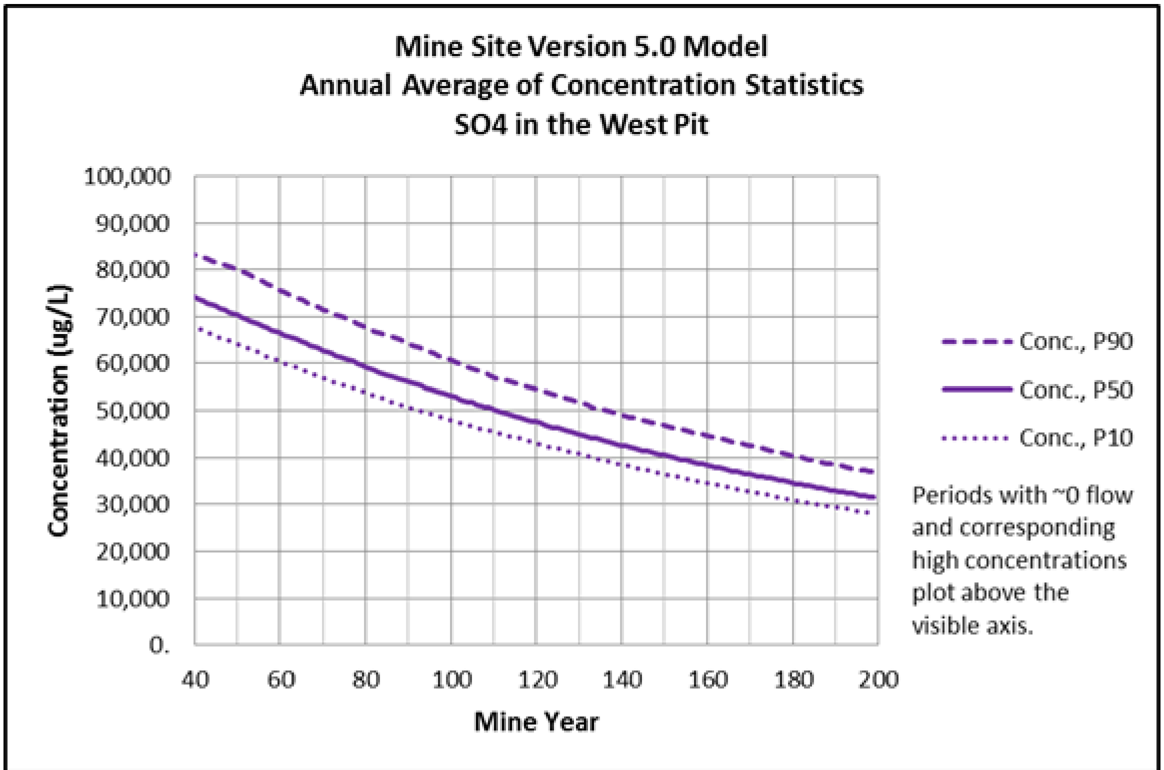


Figure 5.2.2-39 Average P90 Concentration of Sulfate in the West Pit over 200 Years

The East Pit and West Pit would be permanent features and would continue to contribute contaminant load to the Partridge River. As mentioned above, however, the solute concentrations in the East Pit and West Pit are predicted to decline over time as the pit walls are flooded. Further, the rate of groundwater seepage from the East Pit and West Pit is small (i.e., 3.75 and 6.1 gpm, respectively) and the relative contaminant load contribution from these sources is predicted to be proportionally small.

Therefore, the only long-term sources of contamination from the NorthMet Project Proposed Action would be the small rate of groundwater seepage from the East Pit and West Pit (which includes seepage from the Category 1 Stockpile) and the WWTF effluent discharge, but the water quality of all of these sources is expected to improve over time as the pit walls are flooded and fewer solutes have the opportunity to be oxidized and released.

5.2.2.3.3 Embarrass River Watershed

This section discusses environmental effects of the NorthMet Project Proposed Action on groundwater and surface water hydrology and quality within the Embarrass River watershed. The only chemical generating NorthMet Project Proposed Action features in the Embarrass River Watershed are the Tailings Basin and the Hydrometallurgical Residue Facility. The groundwater and surface water in the Embarrass River Watershed could be affected by seepage from the Tailings Basin, flow augmentation, and WWTP effluent discharges. These potential hydrologic and contaminant sources and their predicted effects on groundwater and surface water hydrology and quality are evaluated below.

Effects on Groundwater Hydrology

This section discusses the environmental consequences of the NorthMet Project Proposed Action on groundwater hydrology within the Embarrass River watershed, specifically from the Tailings Basin and associated engineering controls. There are no other NorthMet Project facilities within the Embarrass River watershed that would affect groundwater hydrology as the hydrometallurgical residue facility would be double-lined and monitored with any accidental seepage quickly identified and collected.

As discussed in Section 4.2, PolyMet proposes to reuse the existing LTVSMC tailings basin. Seepage from the existing LTVSMC tailings basin has decreased since LTVSMC operations stopped in 2001, but has reached a current steady state of approximately 2,020 gpm to the Embarrass River watershed. Once the seepage reaches the toe of the Tailings Basin, it divides between flow that remains as groundwater (referred to as groundwater seepage) and flow that exceeds the hydraulic capacity of the aquifer and upwells to the surface (referred to as surface seepage). Under existing conditions, about 209 gpm of Tailings Basin seepage remains as groundwater and about 1,811 gpm upwells to the surface and ultimately contributes to surface water flow in several of the Embarrass River tributaries: Mud Lake Creek, Trimble Creek, and Unnamed Creek (Barr NorthMet Water Modeling Data Package Volume 2 – Plant Site).

Groundwater seepage from the Tailings Basin flows in four flowpaths identified as the North, Northwest, West, and South flowpaths (Figure 5.2.2-6). The North, Northwest, and West flowpaths are within the Embarrass River watershed, while the South flowpath discharges to Second Creek within the Partridge River watershed. Little groundwater would flow to the east because of high bedrock elevations, and essentially all of the groundwater that flows south toward Second Creek would be captured and pumped back into the Tailings Basin.

PolyMet does not propose a liner for the Tailings Basin because of geotechnical concerns; therefore, the addition of tailings and changes in water management due to the NorthMet Project Proposed Action would result in increased seepage from the Tailings Basin relative to existing legacy LTVSMC seepage. As Table 5.2.2-35 indicates, seepage is predicted to increase from 2,020 gpm to approximately 3,380 gpm during operations. Most of this seepage would travel to the north, northwest, and west of the Tailings Basin and could affect groundwater levels in those areas.

Table 5.2.2-35 NorthMet Project Proposed Action Tailings Basin Seepage During Operations

Flowpath	No Action			Proposed Action				
	Tailings Basin Seepage	**Ground-water Seepage**	**Surface Seepage**	**Tailings Basin Seepage**	**Ground-water Seepage**	**Surface Seepage**	**Containment System**	**Ground-water Flow Bypassing Containment System**
North Flowpath	870	44	826	1,990	44	1,946	1,986	4
Northwest Flowpath	610	55	555	770	55	715	764	6
West Flowpath	540	110	430	620	110	510	609	11
Total	2,020	209	1,811	3,380	209	3,171	3,359	21

Source: Barr 2013j.

The NorthMet Project Proposed Action, without any mitigation, would increase Tailings Basin seepage rates by 67 percent and increase groundwater upwelling by over 100 percent. The hydraulic capacity of the surficial aquifer would not change. This increase in upwelling could have a significant effect on downgradient wetlands. Therefore, PolyMet proposed the groundwater containment system that would wrap around the northeast, north, and west sides of the Tailings Basin. This system is designed to capture 100 percent of the surface seepage and 90 percent of the groundwater seepage.

As Table 5.2.2-36 indicates, the net effect of the groundwater containment system would be to decrease groundwater seepage from the Tailings Basin downgradient of the containment system from approximately 209 to 21 gpm. This decrease in groundwater seepage is not expected to have a significant effect on groundwater downgradient from the groundwater containment system as the wetland system in this area is fully saturated with ponded water, so the ponded water would be expected to infiltrate and replace the groundwater captured by the containment system. The effects of the containment system on surface water hydrology are discussed later in this section.

Seepage from the Tailings Basin would decrease once plant operations cease in year 20, reaching a steady state at some point during closure. In fact, during reclamation, PolyMet proposes to provide a bentonite-amended cover to the Tailings Basin, which would reduce seepage from the Tailings Basin to below current LTVSMC conditions. As Table 5.2.2-36 below indicates, seepage from the Tailings Basin to the Embarrass River watershed is predicted to decrease from the estimated current rate of 2,020 gpm to about 1,320 gpm at closure under the Proposed Action (about a 35 percent decrease). The groundwater containment system would remain in place, so the net effect of the NorthMet Project Proposed Action on groundwater hydrology in closure would be approximately a 39 percent reduction in groundwater upwelling (from 1,811 to 1,111 gpm) and a 90 percent reduction in groundwater seepage downgradient of the containment system (from 209 to 21 gpm). As discussed above, the decrease in groundwater seepage is not expected to have a significant effect on groundwater downgradient from the groundwater containment system as the wetland system in this area is fully saturated with ponded water, so the ponded water would be expected to infiltrate and replace the groundwater captured by the containment system. The effects of the containment system on surface water hydrology are discussed later in this section.

Table 5.2.2-36 NorthMet Project Proposed Action Tailings Basin Seepage during Closure

Flowpath	No Action			Proposed Action				
	Tailings Basin Seepage[1]	Ground-water Seepage[1]	Surface Seepage[1]	Tailings Basin Seepage[1]	Ground-water Seepage[1]	Surface Seepage[1]	Containment System[1]	Ground-water Flow Bypassing Containment System[1]
North Flowpath	870	44	826	550	44	506	546	4
Northwest Flowpath	610	55	555	440	55	385	434	6
West Flowpath	540	110	430	330	110	220	319	11
Total	2,020	209	1,811	1,320	209	1,111	1,299	21

Source: Barr 2013j.

[1] All units are gpm.

Effects on Groundwater Quality

The NorthMet Project Proposed Action could affect surficial groundwater quality within the Embarrass River watershed by leaching metals, sulfate, and other solutes from the NorthMet Tailings Basin. The Tailing Basin would be the only source of groundwater contaminants from the NorthMet Project within the Embarrass River watershed. The only other project feature located in the Embarrass River watershed would be the Hydrometallurgical Residue Facility, but this facility would have a double geomembrane liner with a leachate collection system between the liners, so the contribution from this facility is considered negligible.

Most seepage from the Tailings Basin would flow along the North, Northwest, and West flowpaths towards the Embarrass River and would affect downgradient groundwater quality. Several sources contribute solutes to the Tailings Basin, including both the existing LTVSMC tailings and NorthMet Project Proposed Action tailings themselves, Mine Site process water, which is pumped to the Tailings Basin through year 11, Colby Lake makeup water, and a negligible amount of 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 effluent concentrations prior to pumping to the Tailings Basin. Groundwater is also the primary pathway for transporting contaminants from the Tailings Basin and is thus a critical component in the model for estimating effects on surface water.

These solutes can be released from tailings by direct dissolution of minerals, but solutes of concern are primarily released 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 and the rate of oxidation and associated solute release would depend strongly on the porosity of the tailings and their moisture content, where higher moisture content corresponds to lower rates of oxygen diffusion and associated oxidation and contaminant release. Thus, the unsaturated tailings in the embankment and beach areas are expected to have higher oxidation rates than the saturated tailings below the pond.

Pilot testing using the final Processing Plant design resulted in average sulfur concentrations in the tailings of 0.12 percent, which is low enough to ensure that they would never produce acidic leachate as they weather. Pore water metal concentrations can increase dramatically if pH decreases, especially for nickel and cobalt (SRK 2007c). The oxyanions (arsenic, antimony, and selenium), however, tend to have increasing solubility with higher pHs.

Testing of tailings containing 0.2 percent sulfur by the MDNR and from the nearby Babbitt Deposit did not result in acidic leachate because silicate weathering was sufficient to neutralize the acid produced. Humidity cell test results for NorthMet Project Proposed Action tailings have tended to support the research by the MDNR and the results from the Babbitt Deposit (Day 2009). Leachate showed an initial decline in pH, but has subsequently remained between 6.0 and 7.8 with no trend toward lower pHs.

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 from the NorthMet Project Proposed Action tailings would pass through the underlying existing LTVSMC tailings (i.e., previous taconite tailings). These underlying tailings may attenuate metals leached from the NorthMet Project Proposed Action 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 Project Proposed Action leachate and the existing LTVSMC tailings. Based on kinetic testing, the pH of NorthMet Project Proposed Action leachate is expected to be about the same as the existing pH of the existing LTVSMC tailings, so no induced leaching is expected due to differences in pH between the NorthMet Project Proposed Action leachate and the existing LTVSMC tailings (Day 2008).

The Tailings Basin pond would primarily receive solute loadings from the tailings, treated Mine Site process water (during years 1 to 11), and captured seepage from the groundwater containment system. The Tailings Basin pond, in turn, would become a primary source of contaminants as its water seeps into the tailings. Therefore, the composition of the Tailings Basin pond, which would be a permanent feature of the Tailings Basin, is an important component in the quality of water that would be discharged from the Tailings Basin tailings. Thus, PolyMet proposes to use the WWTP to treat the pond water. The presence of the pond in closure would provide benefits as it creates a saturated layer that would permanently reduce the oxygen flux and associated solute release in the underlying tailings.

Engineering Controls

PolyMet does not propose to line the Tailings Basin, nor is the existing underlying existing LTVSMC Tailings Basin lined. In lieu of a liner, PolyMet proposes three engineering controls to reduce the release and transport of contaminants from the Tailings Basin (Figure 5.2.2-40):

- the Tailings Basin groundwater containment system (referred to as the groundwater containment system),
- bentonite amendment of tailings during reclamation to reduce oxygen flux and water percolation during reclamation and closure, and

- active treatment of the Tailings Basin pond water and collected tailings seepage by the WWTP.

Tailings Basin Groundwater Containment System

The groundwater containment system would be installed prior to plant operations and would consist of a groundwater collection system along the outside perimeter of the Tailings Basin where seepage has the potential to enter the surficial aquifer. (Figure 3.2-28). The design includes a hydraulic barrier (cutoff wall) that would be keyed into bedrock, with a collection trench and drain pipe installed on the upgradient side (Figure 3.2-29). The trench and piping would convey the collected seepage to two pumping stations, which would pump the seepage during operations to either the Tailings Basin pond for reuse, or any excess seepage to the WWTP for treatment prior to discharge. The groundwater containment system would continue to operate during reclamation and closure, although in those phases the seepage could not be reused as process water, but would be treated at the WWTP and used for stream flow augmentation. augmentation and filling of the West Pit. The groundwater containment system is assumed to capture 90 percent of the groundwater flow that approaches the system (PolyMet 2013g).

Wastewater Treatment Plant

PolyMet proposes a WWTP to treat water in the tailings pond and tailings seepage collected by the groundwater containment system. The WWTP would treat water throughout the entire mine life (operations, reclamation, and closure). The WWTP would essentially treat all Tailings Basin seepage except for the small quantity (i.e., 21 gpm) that would bypass the groundwater containment system. The WWTP would discharge treated effluent to augment stream flow during operations (about 1,574 gpm at representative year 10) and closure (2,020 gpm). During reclamation, the WWTP effluent would be pumped to the West Pit to accelerate flooding. The level of water treatment at the WWTP would be designed to be sufficient to meet surface water evaluation criteria.

Bentonite-amended Tailings Cover

After operations cease in year 20, PolyMet proposes to cover the NorthMet Project Proposed Action tailings beach adjacent to the exterior embankment with a bentonite amendment to limit water infiltration and reduce oxidation of the tailings. PolyMet would also inject the tailings below the pond with bentonite using pre-manufactured agricultural equipment mounted on a pontoon. The bentonite amendment engineering control would create an 18-inch-thick layer at the surface of the Tailings Basin tailings dams/beaches and on the pond bottom during reclamation (PolyMet 2012d, Sections 7.1 and 7.2). In the unsaturated beaches and dams, the bentonite layer is designed to maintain a layer that remains at or above approximately 90 percent saturation—a condition that would cause the tailings to act as a barrier to diffusive oxygen transport. A bentonite layer would also be placed at the bottom of the tailing pond to reduce hydraulic conductivity, with the design goal of reducing pond seepage flux to 6.5 in/yr or less.

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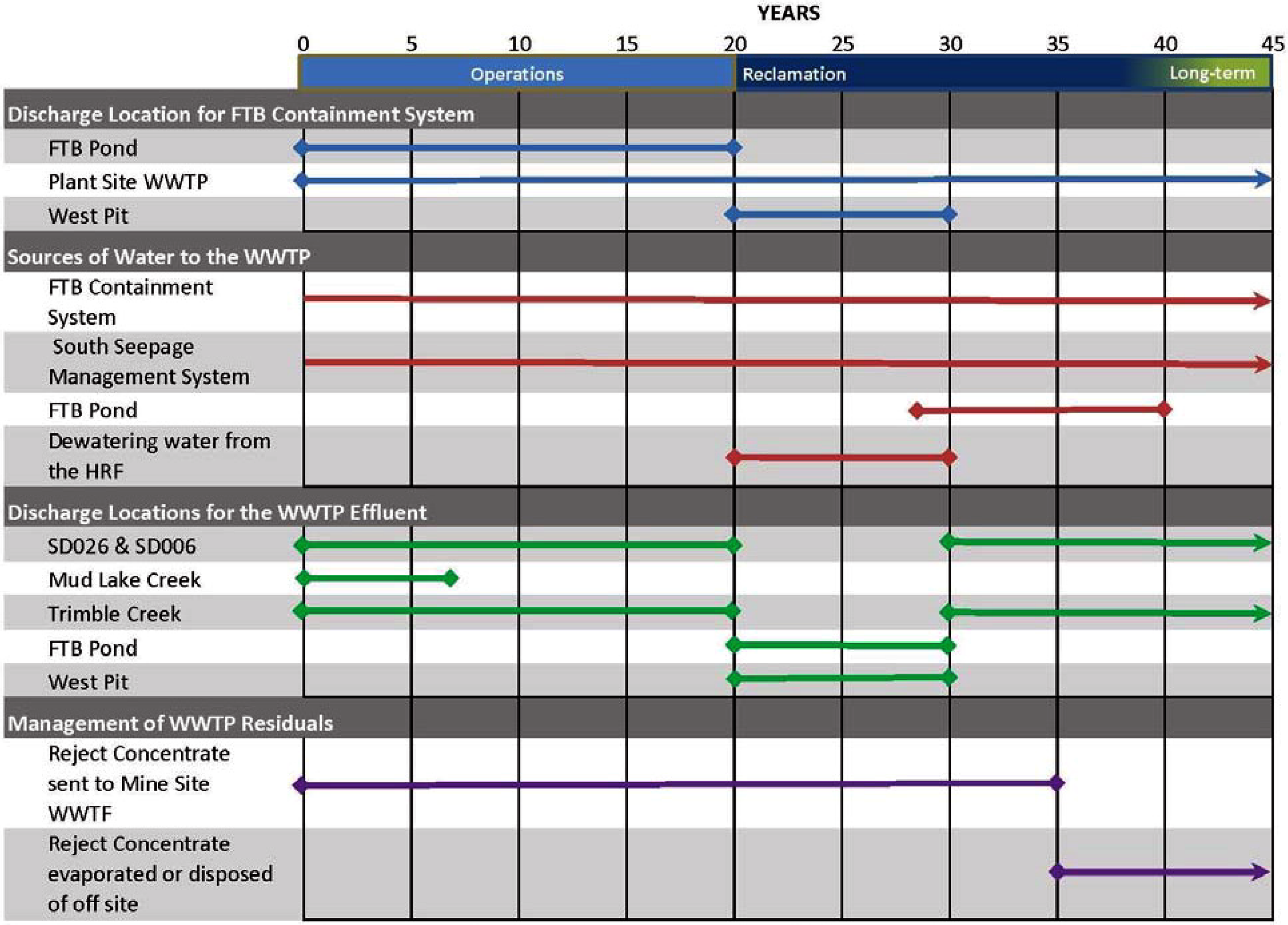

Note: Actual start and end years are variable due to uncertainties and variability in the water and chemical balances. Dates shown are approximate.

Figure 5.2.2-40

Plant Site Water Management Timeline with Mechanical Treatment

NorthMet Mining Project and Land Exchange PSDEIS

Minnesota

DRAFT SUBJECT TO REVISION

April 2013

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Groundwater Transport and Evaluation Locations

Groundwater flow away from the tailings is tracked in four groundwater flowpaths: North, Northwest, West, and South (Figure 5.2.2-6). Two groundwater quality evaluation points are selected along each flowpath—one at the property boundary and a second at the location where groundwater is predicted to discharge to the surface. These surface discharge points are Mud Lake Creek (North Flowpath), Trimble Creek (Northwest Flowpath), and the Embarrass River at Unnamed Creek (West Flowpath). Because of the bedrock topology present at the southern portion of the Tailings Basin, nearly all of the groundwater flowing south from the Tailings Basin would be captured by the seepage barrier at the headwaters of Second Creek, which would return it to the Tailings Basin, thus groundwater evaluation points are not needed for the South flowpath.

The time at which contaminants leached from the Tailings Basin would begin to affect water quality at these evaluation points depend on the following two variables:

- the rate at which contaminants would move in groundwater (essentially the groundwater flow rate, except for the constituents arsenic, antimony, copper, and nickel, which are assumed to be attenuated relative to groundwater flow), as modified by the groundwater containment system; and
- the distance between the source and the evaluation point.

The groundwater travel velocity would depend, in turn, on aquifer porosity, hydraulic conductivity, hydraulic gradient, aquifer thickness, and recharge rate. The hydraulic characteristics of each Plant Site groundwater flowpath (median values) and estimates for solute travel time to each groundwater evaluation point are summarized in Table 5.2.2-11.

The time at which unattenuated solutes in the tailings leachate are expected to reach their surface discharge points (i.e., the "sharp-front" arrival times, in years after start of mining, that were calculated using an analytical calculation) are 439 years for the West flowpath, 425 years for the Northwest Flowpath, and 430 years for the North flowpath (Table 5.2.2-11).

To ensure that the GoldSim model would identify potential effects that groundwater contaminants would have on the receiving surface waters, Barr Engineering conducted a 500-year simulation of groundwater-transport in the Plant Site area. Model results for solute migration in Plant Site groundwater are illustrated here using the predicted concentration over time of lead at the surface discharge points for the three flowpaths (i.e., West, Northwest, and North; Figure 5.2.2-41). Cobalt was used to illustrate groundwater transport at the Mine Site, but lead is used to illustrate Plant Site transport because it is leached from NorthMet Project Proposed Action tailings at concentrations higher than baseline groundwater, is modeled as an unattenuated solute, and has an evaluation criterion in the receiving surface waters.

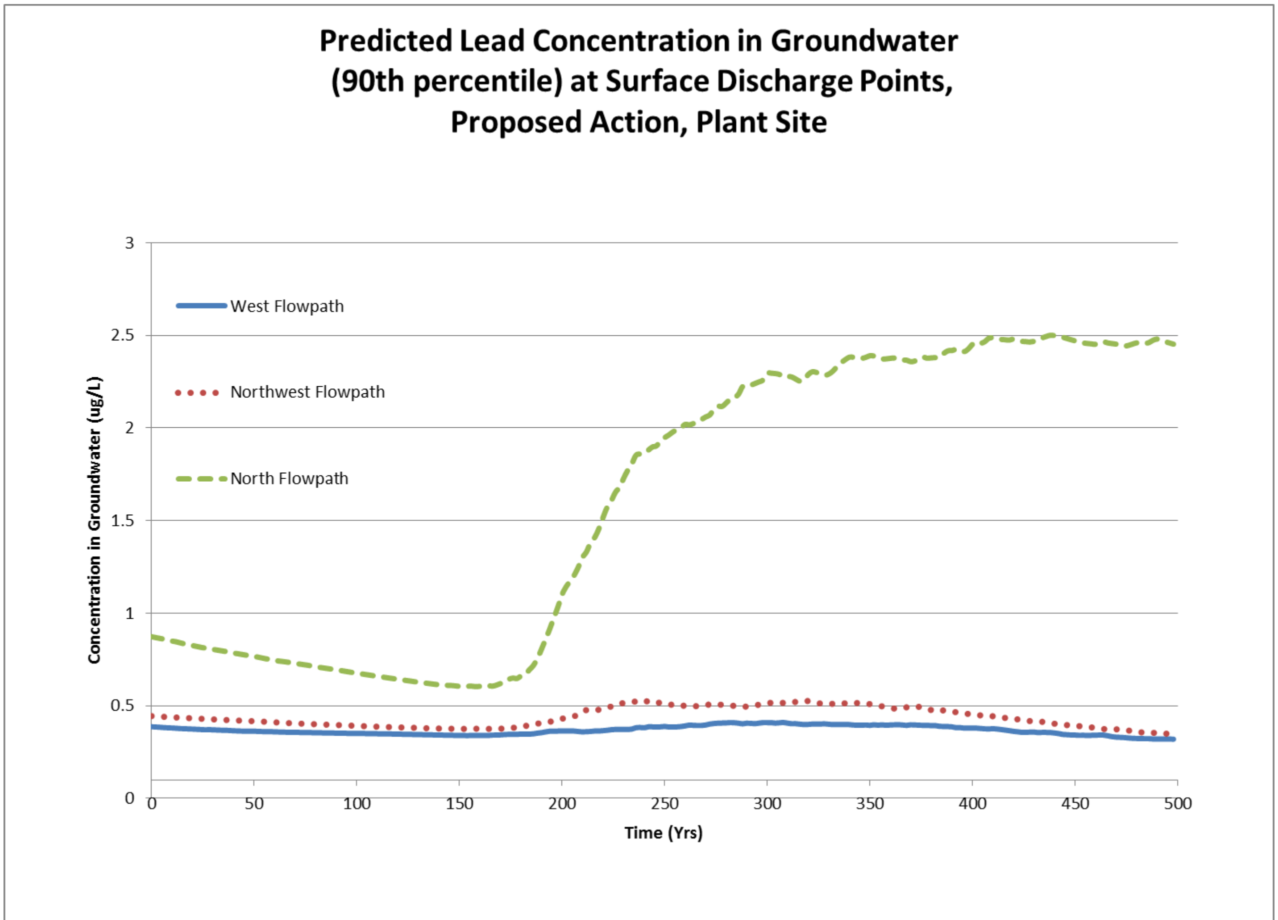

Figure 5.2.2-41 Predicted Lead Concentrations (90th Percentile) at Surface Discharge Points

Surficial Groundwater Quality at the Evaluation Locations

Results of the GoldSim water quality modeling were reviewed for all 28 constituents at all three surficial flowpath evaluation locations. A screening process was used to identify any constituents and locations that warranted a more robust examination because of potential exceedances of water quality evaluation criteria. The screening process involved comparing the single highest monthly P90 water quality prediction from among the 6,000 months covered by the simulation (i.e., 12 months times 500 years) for each constituent at each of the five evaluation locations. These NorthMet Project Proposed Action modeled values were compared with both the NorthMet Project No Action Alternative modeled values and the evaluation criteria discussed previously. Each contaminant that was identified as exceeding the numerical evaluation criteria was then evaluated in more detail to understand the cause of the potential exceedance.

The screening of maximum predicted 90th-percentile groundwater concentrations of all modeled solutes indicated that across all three flowpaths, none of the solutes are predicted to ever exceed the evaluation criteria at the P90 level. Table 5.2.2-37 presents the maximum P90 values for the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative in comparison with the evaluation criteria. Figure 5.2.2-42 illustrates the range of model predictions for each solute (minimum P10 to maximum P90 values) over the 500-year simulation. Figure

5.2.2-44 illustrates the relative change between the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative P90 values (i.e., if the values are the same the relative change ratio would be 1; values greater than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in an increase in solute concentrations relative to the NorthMet Project No Action Alternative; conversely, values less than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in a decrease in solute concentrations relative to the NorthMet Project No Action Alternative).

Although the GoldSim results do not show any exceedances of groundwater quality evaluation criteria, a more detailed discussion of TDS is warranted and provided below.

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Table 5.2.2-37 Maximum Predicted P90 Concentrations over 500-year Model Simulation Period at All Groundwater Evaluation Points Along Modeled Flowpaths in the Plant Site Surficial Aquifer (NorthMet Project Proposed Action)

Parameter	Groundwater Evaluation Criterion[1]	Units	North Flowpath at Property Boundary		North Flowpath before MLC2		Northwest Flowpath at Property		Northwest Flowpath before TC1		West Flowpath at Property		West Flowpath before Embarrass River	
General			Proposed Action	No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action	No Action
Alkalinity	NA	mg/L	196	197	150	150	187	188	143	144	165	165	142	142
Calcium	NA	mg/L	39.3	39.4	34.8	34.9	62.5	63.0	47.9	48.1	58.1	58.1	49.6	49.6
Chloride	250	mg/L	18.2	18.3	13.9	14.0	18.2	18.5	13.8	14.0	16.1	16.2	13.5	13.7
Fluoride	4	mg/L	3.1	3.1	2.3	2.3	1.2	1.3	1.0	0.97	0.82	0.82	0.70	0.70
Hardness	NA	mg/L	294	295	216	216	501	505	328	331	436	437	341	342
Magnesium	NA	mg/L	47.7	47.9	31.3	31.5	84.1	84.7	50.8	51.5	70.9	71.1	53.0	53.1
Potassium	NA	mg/L	6.3	6.3	4.4	4.4	6.0	6.0	4.1	4.1	5.2	5.2	4.2	4.2
Sodium	NA	mg/L	36.7	36.9	21.9	22.0	31.5	31.6	19.3	19.3	24.1	24.2	18.2	18.2
Sulfate	250	mg/L	158	170	118	122	204	230	150	163	193	218	159	172
Metals														
Aluminum	NA	µg/L	78.7	45.2	86.4	62.4	78.6	45.5	87.2	62.2	84.1	54.2	78.6	62.5
Antimony	6	µg/L	0.32	0.31	0.33	0.33	0.28	0.28	0.31	0.30	0.30	0.29	0.30	0.30
Arsenic	10	µg/L	3.6	3.6	2.8	2.8	1.8	1.8	1.4	1.4	1.4	1.4	1.3	1.3
Barium	2000	µg/L	172.1	174	143.2	144	82.3	82.8	82.2	82.5	78.8	73.5	75.0	75.0
Beryllium[2]	0.49	µg/L	0.30	0.24	0.30	0.26	0.30	0.24	0.30	0.26	0.30	0.25	0.30	0.25
Boron	1000	µg/L	262	268	200	204	355	376	266	278	329	337	274	277
Cadmium	4	µg/L	0.36	0.15	0.22	0.15	0.19	0.17	0.17	0.16	0.17	0.17	0.15	0.15
Chromium	100	µg/L	1.6	0.81	1.3	0.94	1.2	0.85	1.2	0.98	1.1	0.92	1.1	0.97
Cobalt	NA	µg/L	4.4	1.6	1.7	1.1	1.6	2.9	1.2	1.9	1.6	2.7	1.3	2.1
Copper	NA	µg/L	2.7	2.7	3.2	3.2	2.9	2.9	3.3	3.3	3.1	3.1	3.4	3.4
Iron	NA	µg/L	1,149	1,350	852	946	2,436	2,803	1,782	1,968	2,389	2,729	1,958	2,147
Lead	NA	µg/L	5.8	1.1	2.5	0.87	1.1	0.56	0.53	0.46	0.58	0.46	0.41	0.40
Manganese[2]	1,506	µg/L	759	522	722	575	1,033	1,197	925	977	1,043	1,165	962	1,026
Nickel	100	µg/L	4.3	4.2	5.1	5.0	4.9	4.8	5.5	5.5	5.3	5.2	5.5	5.5
Selenium	30	µg/L	1.3	0.81	1.2	0.95	1.1	0.80	1.1	0.93	1.1	0.87	1.1	0.88
Silver	30	µg/L	0.09	0.11	0.08	0.09	0.07	0.11	0.07	0.09	0.07	0.10	0.07	0.09
Thallium[2]	0.6	µg/L	0.17	0.19	0.17	0.18	0.17	0.18	0.17	0.17	0.17	0.18	0.16	0.17
Vanadium	50	µg/L	5.7	5.0	5.7	5.3	5.2	3.7	5.5	4.6	5.3	4.0	5.4	4.4
Zinc	2000	µg/L	32.4	16.5	25.9	18.9	22.7	13.4	22.5	17.1	21.6	15.0	21.0	16.7

Source: Barr 2013f.

[1] References for the groundwater evaluation criteria are summarized in Table 5.2.2-1.
[2] Beryllium, Manganese, and Thallium (Mine Site bedrock unit only). The evaluation criterion differs by location based on background water quality (see Table 5.2.2-1).

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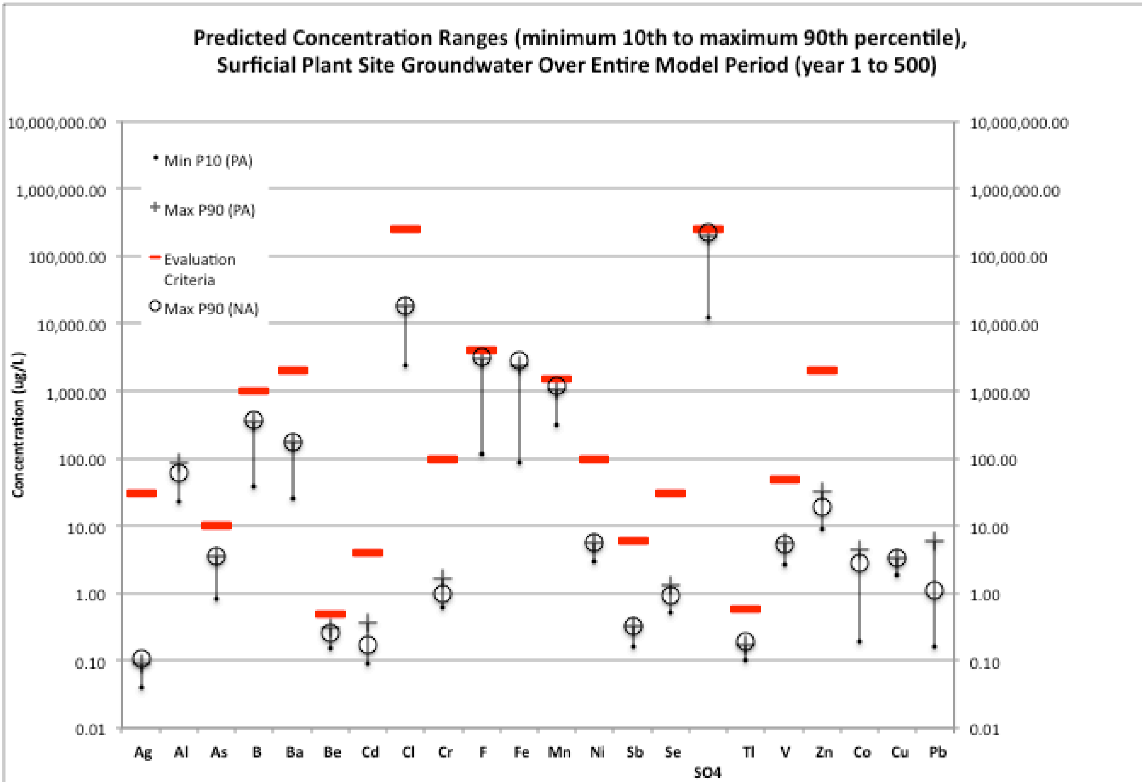


Notes: PA = NorthMet Project Proposed Action; NA = modeled No Action Alternative

Figure 5.2.2-42 Predicted Concentration Ranges (Minimum 10th to Maximum 90th Percentile) of Groundwater at the Plant Site over the Entire Model Period

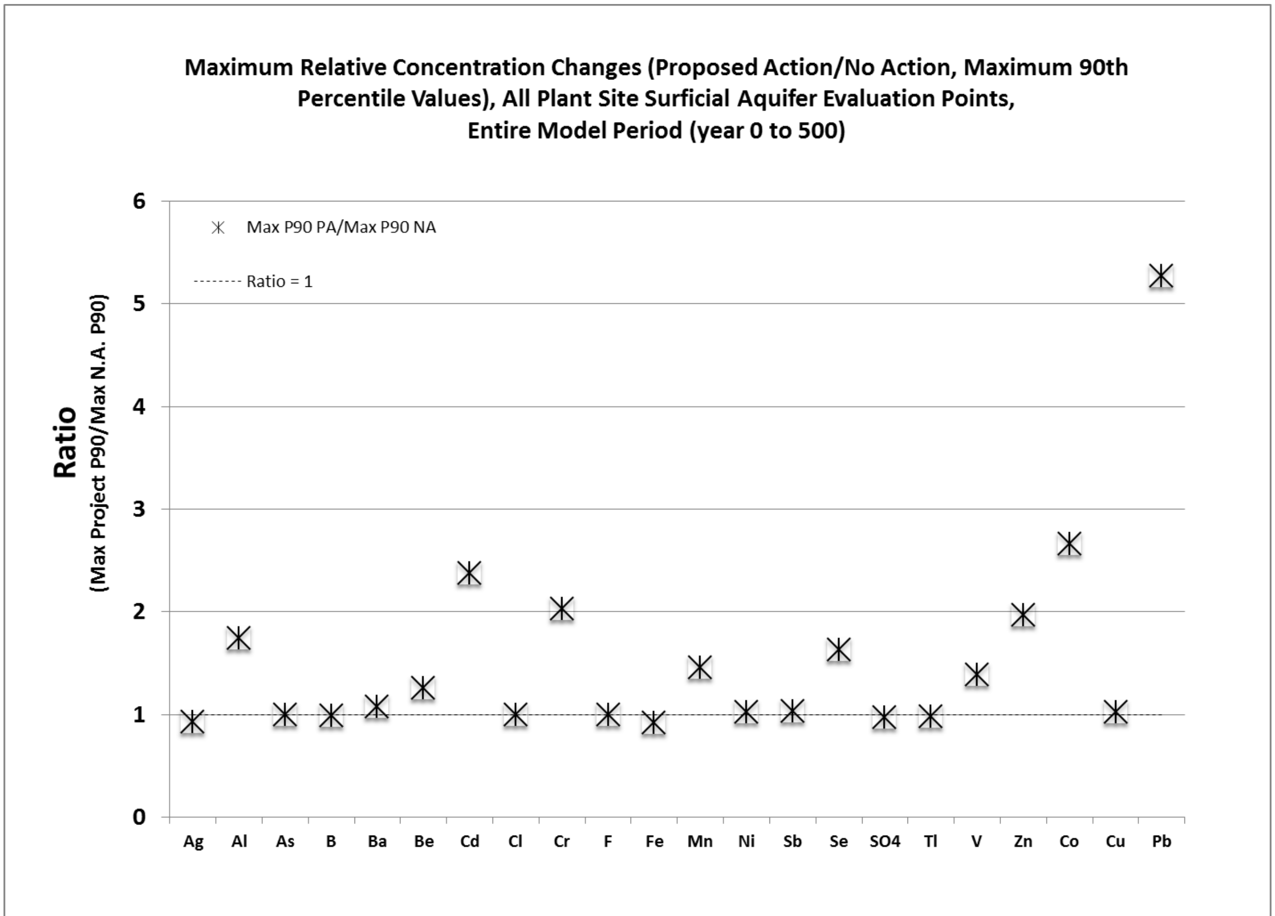
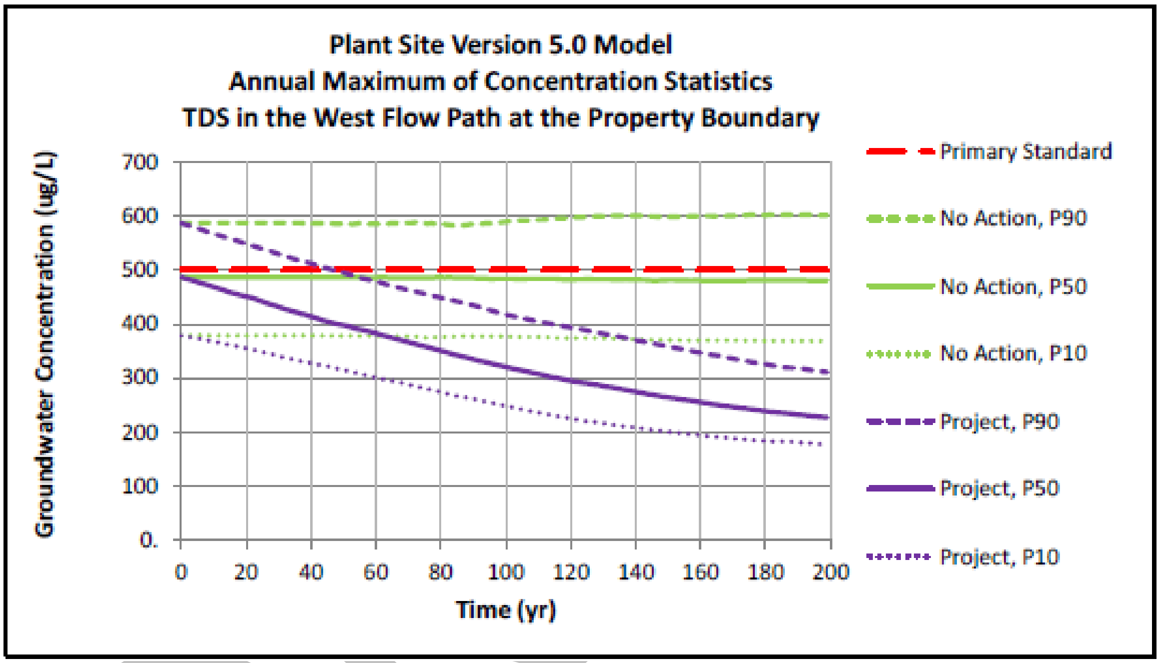


Figure 5.2.2-43 Maximum Relative Concentration Changes (NorthMet Project Proposed Action/No Action Alternative) at Surficial Aquifer Evaluation Locations, Entire Model Period

Total Dissolved Solids

The water quality evaluation criteria include TDS for groundwater (500 mg/L, Table 5.2.2-2), but the NorthMet Project Proposed Action water-quality model did not directly model TDS. TDS can be indirectly estimated by summing instantaneous concentrations of each of the 8 constituents that comprise TDS (i.e., alkalinity, calcium, chloride, fluoride, magnesium, potassium, sodium, and sulfate). PolyMet conducted modified simulations that calculated P90 values for TDS at each model time step based on the sum of these major ions concentrations predicted in the GoldSim Plant Site model. This analysis shows that estimated TDS concentrations would exceed the evaluation criteria for all three Tailings Basin flowpaths (see 5.2.2-44 for the West Flowpath as an example).



Source: PolyMet 2013i.

Figure 5.2.2-44 Total Dissolved Solids Estimates in the West Flowpath at the Property Boundary

Upon closer examination, however, it is clear that the exceedances only occur in the early model years (years 0 to approximately 55) and are a result of elevated baseline TDS concentrations that are also reflected in the NorthMet Project No Action Alternative TDS predictions for all three flowpaths. In each case, the predicted TDS concentrations decrease from year 0 such that all three flowpaths are predicted to eventually meet the P90 TDS evaluation criteria (i.e., year 10 in the North Flowpath, year 50 for the West Flowpath, and year 55 for the Northwest Flowpath). This decrease in TDS concentrations over time is attributable to the NorthMet Project Proposed Action groundwater containment system, which is designed to capture at least 90 percent of the groundwater flowing from the Tailings Basin, including existing seepage from the existing LTVSMC tailings that is responsible for the baseline TDS exceedances.

The NorthMet Project Proposed Action is predicted to reduce TDS concentrations and eventually meet groundwater evaluation criteria.

Effects on Surface Water Hydrology in the Embarrass River Watershed

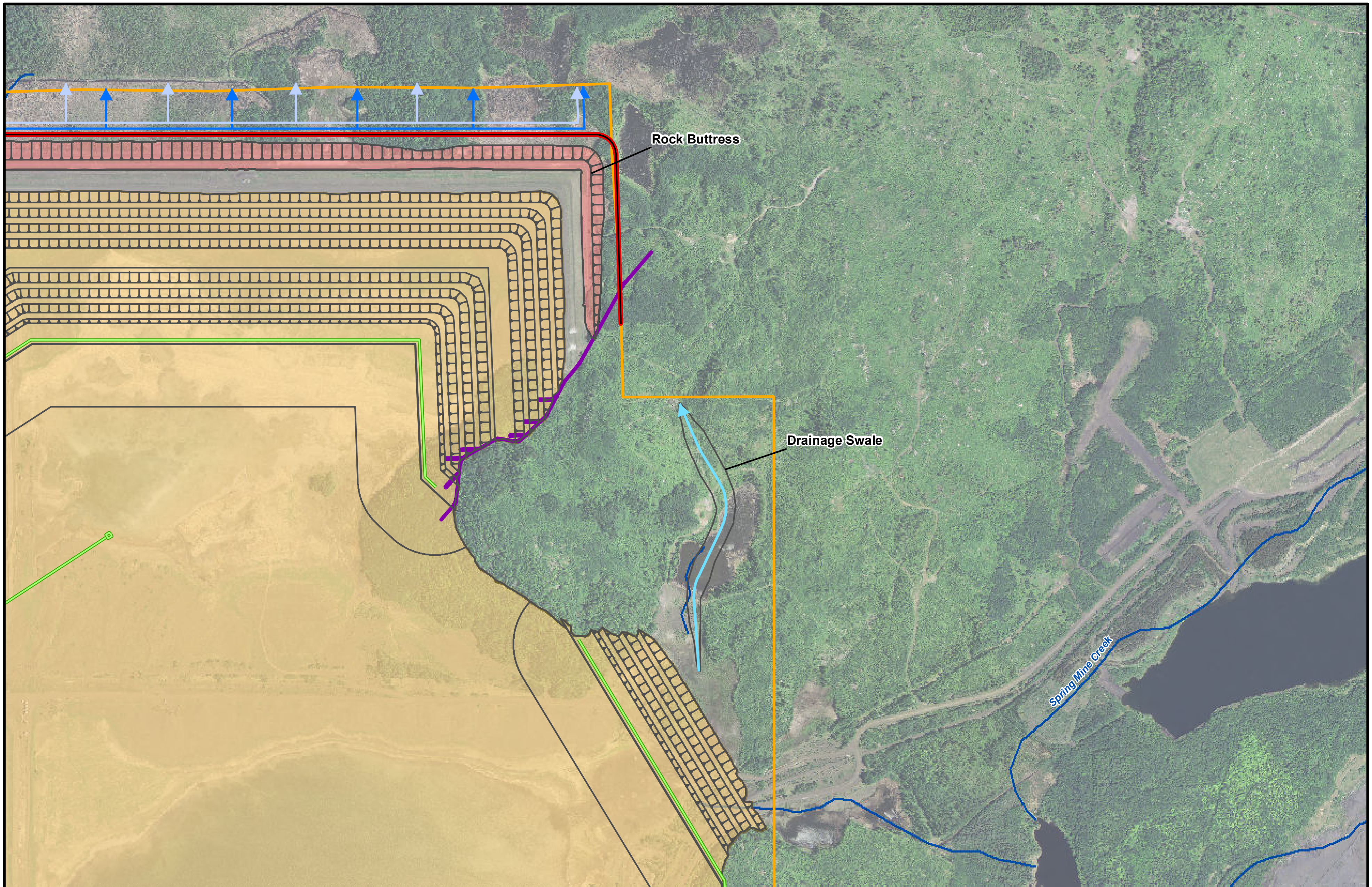
This section describes the effects of the NorthMet Project Proposed Action on the surface water hydrology of the Embarrass River and its tributaries. The effects of the NorthMet Project Proposed Action on surface water hydrology, especially in the three tributary streams draining the Tailings Basin (i.e., Mud Lake Creek, Trimble Creek, and Unnamed Creek) are complex, as some project features/engineering controls would tend to increase flows while others would decrease flows, and change over time. For example, during mine operations, the NorthMet Project Proposed Action would increase seepage from the Tailings Basin as a result of tailings deposition, but most of this seepage would be captured by the groundwater containment system, which this reduction in flow would in turn be mitigated by the proposed tributary stream flow augmentation. The NorthMet Project Proposed Action would also slightly modify some watershed areas within the Embarrass River, which would affect stream flows. These NorthMet Project Proposed Action effects on surface water hydrology are described in more detail below.

Mud Lake Creek Watershed Alteration

The Tailings Basin has a contributing watershed immediately to the east of Cell 1E that drains into the cell. In year 7 of mine operations, the East Dam would be constructed to enable tailings deposition into Cell 1E. At that time, the watershed that currently drains into Cell 1E would be rerouted via a constructed drainage swale to drain to the headwaters of Mud Lake Creek. After year 7, there would be no need for augmentation to Mud Lake Creek because of the additional runoff water resulting from the swale diversion. Figure 5.2.2-45 shows the approximate location of the drainage swale. Construction of the swale diversion would increase the Mud Lake Creek Watershed area at MLC-3 from 1.34 mi^2 to 2.24 mi^2.

Effects on Tributary Stream Flow

The NorthMet Project Proposed Action includes construction of the groundwater containment system along the north and west sides of the Tailing Basin, which would capture virtually all of the Tailings Basin seepage presently flowing in those directions to maintain water quality. Seepage and local runoff captured by these systems would be pumped back into the Tailings Basin or to the WWTP. As indicated in Table 5.2.2-38, the groundwater containment system during the operations phase would reduce flow (relative to existing conditions) in Mud Lake Creek (i.e., North Flowpath) by 37 percent, in Trimble Creek (i.e., Northwest Flowpath) by 65 percent, and in Unnamed Creek (i.e., West Flowpath) by 46 percent. The MDNR has recommended that maintaining surface flows within about plus or minus 20 percent of existing conditions in mining-affected streams should be a management objective where reasonably practical in order to maintain existing aquatic ecology.



Plant Site
Drainage Flow Direction
Tailings Pipeline
Treated Water Discharge Pipe
Colby Lake Transfer
Containment System
Tailings Basin Emergency Overflow
Tailings Basin
Rock Buttress

US Army Corps of Engineers St. Paul District

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

N W E S

0 250 500 1,000 1,500 Feet

Figure 5.2.2-45
Mud Lake Creek Headwaters Diversion
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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April 2013

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Table 5.2.2-38 Average Annual Flow Conditions in the Tributaries

	Mud Lake Creek (MLC-3) (gpm)	**Trimble Creek (TC-1) (gpm)**	**Unnamed Creek (PM-11) (gpm)**
Current total Tailings Basin seepage to watershed(1)	1480		540
Seepage split to groundwater(2)	44	55	110
Seepage split to the tributaries(3)	207	1174	430
Existing contribution from the watershed(4)	458	714	750
Total annual average surface flow(5)	665	1888	1180
Proposed annual average surface flow	418	665	640
% reduction from existing to proposed	37	65	46

Source: Barr 2013a, Table 1.

[1] Average annual seepage to the toes of the Tailings Basin (splits into items 2 and 3)
[2] Average aquifer capacity at the upstream end of each flowpath (Barr 2013i, Table 1).
[3] Flow (seepage – aquifer capacity) that reports to each tributary. Note that 75 percent of the seepage from the north bank (870 gpm) of Cell 2E that *does not* stay in the aquifer, but actual reports to Trimble Creek because of the location of the watershed divide.
[4] Watershed area includes both the undisturbed watershed areas and the outer banks of the Tailings Basin.
[5] Sum of lines 3 and 4.

PolyMet has proposed to augment flow by distributing treated effluent from the WWTP among these three tributary streams to maintain average annual flow to within 20 percent of existing conditions. Table 5.2.2-39 shows the minimum required and maximum allowable (plus or minus 20 percent of existing average annual tributary stream flow) augmentation that would be discharged on an average annual basis from the WWTP and Colby Lake to each of the three tributaries. The discharge locations would be downstream of the groundwater containment system and would likely involve multiple spigot points so as to minimize effects on nearby wetlands.

Table 5.2.2-39 Determination of Combined Flow Requirement from the WWTP and Colby Lake

	Mud Lake Creek (MLC-3)[5] (gpm)	Trimble Creek (TC-1) (gpm)	Unnamed Creek (PM-11) (gpm)	Second Creek (SD026) (gpm)
Total annual average surface flow[1]	665	1888	1180	500
Expected future contribution from the watershed[2]	439 / 734	599	664	0
Minimum requirement from WWTP/Colby Lake[3]	93 / 0	911	280	400
Maximum allowable from WWTP/Colby Lake[4]	359 / 64	1667	752	600

Source: Barr 2013a, Table 2.

1 Equivalent to line 5 of Table 5.2.2-36.
2 The future contribution from the watershed decreases because the containment system, which is away from the toes of the Tailings Basin, removes watershed area and any runoff from the outer banks of the Tailings Basin.
3 80 percent of the existing total annual average surface flow, less the expected future watershed contribution
4 120 percent of the existing total annual average surface flow, less the expected future watershed contribution.
5 X / Y values: X indicates the flow values before the drainage swale is in place; Y indicates the flow values after the watershed area to Mud Lake Creek is increased (from 1.34 to 2.24 mi^2) because of the construction of the drainage swale at time > 7 years.

The total flow required from the WWTP effluent and/or Colby Lake prior to construction of the Mud Lake Creek drainage swale would be between 1,684 and 3,378 gpm on an average annual basis (plus or minus 20 percent of the current total annual average surface flow, less the expected future watershed contribution, summed for all tributaries).

Table 5.2.2-40 shows the amount of water that is anticipated to be pumped for augmentation to each tributary, from the two sources, for operations, reclamation, and long-term. During operations, WWTP effluent would be the primary source of augmentation water. There would be times, however, when there would not be sufficient WWTP effluent available to meet the minimum flow requirement in the tributaries, and water would be transferred from Colby Lake on an as-needed basis. During reclamation, all WWTP effluent would be used to help flood the West Pit; therefore during this phase all augmentation water would come from Colby Lake. In closure, it is expected that effluent from the WWTP alone (estimated at approximately 2,000 gpm) would be sufficient to meet the minimum flow augmentation requirements of the tributaries without requiring additional water from Colby Lake.

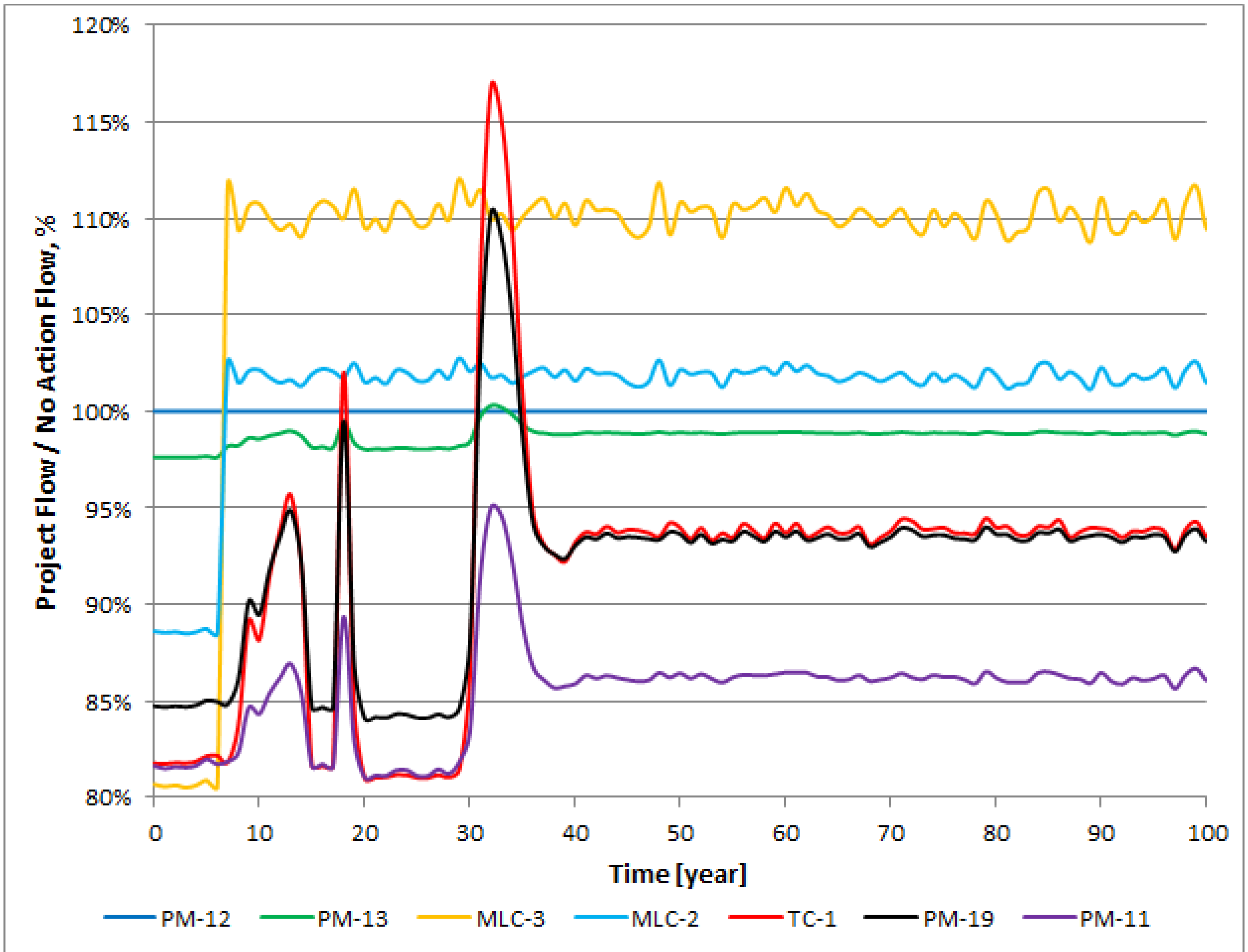
Table 5.2.2-40 Augmentation Flows and Sources to Tributaries for Various Time Periods

	Mud Lake Creek (MLC-3)[1,2]		Trimble Creek (TC-1)[2]		Unnamed Creek (PM-11)[2]		Second Creek (SD026)[2]	
	WWTP	Colby Lake	WWTP	Colby Lake	WWTP	Colby Lake	WWTP	Colby Lake
Minimum Req'd	93		911		280		400	
Operations	28	66	571	399	122	176	251	175
Reclamation	0	0	0	916	0	282	0	402
Closure	0	0	1136	0	349	0	499	0

Source: Computed from Barr 2013a, Tables 3, 4, 5, and 6.

1 Augmentation required only during first 7 years of operation; thereafter, watershed diversion from swale would contribute slightly more flow than existing conditions.
2 All units are gpm.

Figure 5.2.2-46 shows the predicted effectiveness of the proposed flow augmentation in maintaining annual average tributary stream flow within 20 percent of existing conditions (i.e., No Action Alternative). The graph only shows up to year 100 because the results are steady beyond that point.



Source: PolyMet 2013j, Figure 6-75.

Figure 5.2.2-46 Average Annual Embarrass River and Tributary Flows in the Project Model (Percent of the NorthMet Project No Action Alternative)

Hydrologic fluctuations throughout operations and closure (first 40 years) are due to changes in the available amount of WWTP effluent, and changing the augmentation water source between the WWTP and Colby Lake. At no time, however, do flows change by more than 20 percent threshold of the NorthMet Project No Action Alternative conditions. The maximum expected change in average annual flow during this time period would occur at TC-1, varying from about -19 percent to +17 percent. The maximum combination of tributary hydrologic effects on average annual flow at Embarrass River location PM-13 is about -2.5 percent. In the long-term, Mud Lake Creek would experience an increase in flow of about 10 percent at MLC-3 and 2 percent at MLC-2; Trimble Creek at TC-1 and PM-19 would have reduced flows of about -7 percent; and Embarrass River at PM-13 about have reduced flows of about -1 percent to -2 percent.

Effects on Surface Water Quality

Surface water quality in the Embarrass River tributaries, which presently receive seepage from the existing LTVSMC Tailings Basin, and Embarrass River downstream of the tributaries, would change because of the NorthMet Project Proposed Action. Tributaries include Unnamed Creek to the west of the Tailing Basin, Trimble Creek northwest of the Tailings Basin, and Mud Lake Creek north of the Tailings Basin (Figure 4.2.2-15). These three tributaries flow into the Embarrass River where the combined effects from the NorthMet Project Proposed Action were modeled at location PM-13.

Results of the GoldSim water quality modeling were reviewed for all 28 constituents at all five tributary stream (i.e., MLC-2, MLC-3, TC-1, PM-19, and PM-11) and three Embarrass River (i.e., PM-12, PM-12.2, and PM-13) evaluation locations[1]. A screening process was used to identify any constituents and locations that warranted a more robust examination because of potential exceedances of water quality evaluation criteria (see Table 5.2.2-39 for the tributary streams evaluation locations and Table 5.2.2-40 for the Embarrass River mainstem evaluation locations). The screening process involved comparing the single highest monthly P90 water quality prediction from among the 6,000 months covered by the simulation (i.e., 12 months times 500 years) for each constituent for each of the eight evaluation locations. If the maximum monthly P90 concentration exceeded the evaluation criteria, the screening process identified it for further analysis.

Tables 5.2.2-45 and 5.2.2-46 show that the maximum monthly P90 values for the NorthMet Project Proposed Action do not exceed the applicable evaluation criteria for any of the constituents, except aluminum (at all locations) and possibly lead (at TC-1 and PM-11). A detailed evaluation of these two constituents is provided below. Sulfate is also discussed because waters used for the production of wild rice are found downstream of the Tailings Basin.

Tables 5.2.2-42, 5.2.2-43, and 5.2.2-44 below compare the P10, P50, and P90 modeled concentrations for the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative for selected key constituents at representative years during mine operations, reclamation, and closure at PM-13, which is the most downstream evaluation location that captures all NorthMet Project Proposed Action-related contaminant loadings. As these data show, the sulfate concentrations decrease for the Proposed Action relative to the No Action Alternative across all three probability values and all three mine phases. This trend is primarily attributable to the water quality of the WWTP effluent and Colby Lake, which are the sources of flow augmentation to the tributary streams to offset the groundwater containment system that would otherwise capture nearly all of the Tailings Basin seepage.

As Table 5.2.2-41 illustrates, the WWTP water quality target concentrations are above - the modeled No Action P50 values at PM-13 (shown in Tables 5.2.2-42, -43, and -44) for all selected, key constituents except sulfate. Consequently, when the WWTP effluent is used for augmentation, concentrations of these constituents would increase at PM-13. As Table 5.2.2-44 shows, the metal concentrations at PM-13 are predicted to decrease, while sulfate concentrations

[1] Location UC-1, located at the headwaters of Unnamed Creek, was modeled for NorthMet Project No Action Alternative conditions but not for NorthMet Project Proposed Action conditions because it is located within the containment system. That is, no NorthMet Project Proposed Action-affected water, other than the assumed 10 percent seepage bypass around the groundwater containment system, will pass through this location and leave the Project boundary. Downstream effects on Unnamed Creek are documented at location PM-11.

are predicted to increase, during reclamation relative to operations or closure, which is attributable to the fact that Colby Lake water (with higher sulfate and lower metal concentrations relative to the WWTP effluent) would comprise all of the flow augmentation during this phase as the WWTP effluent would be used to help flood the West Pit during this phase.

Table 5.2.2-41 Comparison of Wastewater Treatment Plant Effluent and Colby Lake Water Quality

Parameter	Unit	WWTP Water Quality Target Concentrations	Colby Lake Average Water Quality
Sulfate	mg/L	10	41
Arsenic	µg/L	10	0.82
Copper	µg/L	9.3	2.7
Lead	µg/L	3.2	0. 25
Nickel	µg/L	52	2.1
Zinc	µg/L	120	3

Source: PolyMet 2013g; Barr 2013.

Despite these predicted increases in concentrations at PM-13, all of these constituents would meet water quality evaluation criteria (Table 4.2.2-42). Although the NorthMet Project Proposed Action evaluation criteria focuses on the P90 values (e.g., a reasonable worst case), the most probable result would be closer to the P50 value, while the P10 value represents a reasonable best case in terms of modeled water quality effects from the NorthMet Project Proposed Action.

Table 5.2.2-42 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and No Action Alternative Modeled Concentrations at PM-13 for Selected Key Constituents, Year 12

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Sulfate	NA	mg/L	151	68.4	169	96.6	188	129
Arsenic	53	µg/L	1.4	2.7	1.6	3.5	1.7	4.3
Copper	8.9	µg/L	1.6	3.2	2.0	4.0	2.5	4.9
Lead	3.0	µg/L	0.4	0.8	0.5	1.0	0.6	1.3
Nickel	49.9	µg/L	2.8	12.2	3.4	16.7	4.0	21.0
Zinc	114	µg/L	9.8	29.4	11.7	38.2	15.5	46.2

Source: PolyMet 2013j.

Table 5.2.2-43 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and No Action Alternative Modeled Concentrations at PM-13 for Selected Key Constituents, Year 24

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Sulfate	NA	mg/L	148	83.0	167	106	191	139
Arsenic	53	µg/L	1.4	1.0	1.6	1.0	1.8	1.0
Copper	8.9	µg/L	1.6	1.8	2.0	2.2	2.5	2.7
Lead	3.0	µg/L	0.4	0.2	0.5	0.3	0.6	0.6
Nickel	49.9	µg/L	2.7	2.5	3.3	3.0	4.0	3.6
Zinc	114	µg/L	9.8	8.6	11.6	10.6	17.7	17.8

Source: PolyMet 2013j.

Table 5.2.2-44 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and No Action Alternative Modeled Concentrations at PM-13 for Selected Key Constituents, Year 200

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Sulfate	NA	mg/L	140	69.6	167	97.7	197	129
Arsenic	53	µg/L	1.4	2.5	1.5	3.0	1.8	3.6
Copper	8.9	µg/L	1.5	3.0	1.92	3.7	2.7	4.5
Lead	3.0	µg/L	0.4	0.7	0.5	0.9	0.6	1.1
Nickel	49.9	µg/L	2.5	10.9	3.2	14.2	4.5	17.6
Zinc	114	µg/L	9.9	10.5	11.6	13.4	16.0	18.4

Source: Barr 2013j.

Table 5.2.2-45 Maximum Modeled Monthly P90 Surface Water Concentrations for Tributary Streams at the Plant Site Over the 500-Year Model Simulation Period

Parameter	**Stream Standard**	**Units**	**MLC-2**		**MLC-3**		**TC-1**		**PM-19**		**UC-1[2]**		**PM-11**	
General			**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**
Alkalinity	NA	mg/L	143	267	83.8	299	100	311	106	301	--	323	100	300
Calcium	NA	mg/L	34.3	47.4	31.0	51.5	35.1	79.3	36.9	77.9	--	118	35.1	110
Chloride	230,000	mg/L	10.4	19.2	10.3	22	7.0	23.5	8.0	22.5	--	24.4	9.0	22.8
Fluoride	NA	mg/L	1.1	3.3	0.19	3.8	0.13	2.9	0.16	2.7	--	1.2	0.16	1.1
Hardness	NA	mg/L	0.21	0.43	109	508	0.12	0.79	139	758	--	1.2	110	1,080
Sulfate	NA	mg/L	59.9	180	44.4	221	59.8	278	61.1	265	--	360	53.5	330
Metals Total											--			
Aluminum	125	µg/L	**173**	**155.5**	**175.9**	**144.4**	**151.1**	**112.5**	**151.5**	**126.8**	**--**	**20.7**	**160.8**	**142.8**
Antimony	31	µg/L	1.5	0.31	2.8	0.31	19.3	0.31	18.5	0.31	--	0.33	18.8	0.31
Arsenic	53	µg/L	3.5	3.78	5.9	4.5	10	3.8	9.8	3.6	--	2.61	10	2.4
Barium	NA	µg/L	91.8	176.6	39.6	197.6	7	149.9	13.3	143.7	--	68.8	7.0	63.7
Beryllium	NA	µg/L	0.25	0.22	0.2	0.2	0.4	0.21	0.39	0.21	--	0.23	0.4	0.21
Boron	500	µg/L	119	276.7	154.4	326.9	385.1	419.2	357.4	403.4	--	**540.2**	367.4	**500.2**
Cadmium	1.4 – 9.03[1]	µg/L	0.2	0.15	0.31	0.15	2	0.16	1.9	0.16	--	0.19	2.0	0.18
Chromium	11	µg/L	2.3	2.11	2.7	2.0	8.0	1.5	7.8	1.8	--	0.73	8.0	2.0
Cobalt	5	µg/L	1.8	1.8	3.1	2.21	5	3.2	4.9	3.1	--	4.65	5	4.3
Copper	5.018 – 38.4[1]	µg/L	4.3	2.62	5.8	2.6	9	3.3	8.9	3.22	--	4.45	9	4.1
Iron	NA	µg/L	3,674	3,416	3,792	3,298	2,665	3,116	2,959	3,202	--	4,540	3,319	4,238
Lead	1.32 – 26.2[1]	µg/L	1.3	1.16	1.9	1.3	**3**	1.07	2.9	1.02	--	0.63	**3**	0.69
Magnesium	NA	µg/L	30,677	77,127	10,444	92,658	11,584	145,290	16,021	140,270	--	216,190	10,943	199,220
Manganese	NA	µg/L	568	486	370	471	142	967	188	956	--	1683	128	1556
Nickel	29.1 – 211.6[1]	µg/L	15.6	4.14	29.4	4.1	50	5.5	49	5.4	--	7.92	50	7.2
Potassium	NA	µg/L	4,116	9,124	1,447	10,514	940	11,370	1,359	10,938	--	12,226	938.46	11,299
Selenium	5	µg/L	1.3	1.23	1.3	1.2	5	0.9	4.9	1.0	--	0.65	5.0	1.1
Silver	1	µg/L	0.13	0.13	0.15	0.13	0.22	0.13	0.21	0.13	--	0.14	0.21	0.14
Sodium	NA	µg/L	22,172	59,747	4,055	69,767	3,250	70,192	5,561	66,871	--	66,575	3,247	61,286
Thallium	0.56	µg/L	0.26	0.25	0.26	0.24	0.24	0.22	0.23	0.22	--	0.21	0.24	0.23
Vanadium	NA	µg/L	5.6	5.4	6.0	5.4	9.6	5.0	9.4	5.2	--	1.8	9.6	5.2
Zinc	66.9 – 221.2[1]	µg/L	21.5	17.9	25.7	17	100	13.8	97.9	15.3	--	7.21	100	15.4

Source: PolyMet 2013j.

1 Range associated with varying hardness; exact numbers vary with modeled hardness at evaluation location.
2 Under the NorthMet Project Proposed Action, this evaluation location (UC-1) would be inside the containment system.
Note: Bold numbers indicate exceedances of the evaluation criteria at the P90 modeled concentrations.

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Table 5.2.2-46 Maximum Modeled Monthly P90 Surface Water Concentrations for the Embarrass River Over the 500-Year Model Simulation Period

Parameter	Stream Standard	Units	PM-12		PM-12.2		PM-13	
General			**Proposed Action**	**No Action**	**Proposed Action**	**No Action**	**Proposed Action**	**No Action**
Alkalinity	NA	mg/L	85.8	85.8	91	91	97.3	179
Calcium	NA	mg/L	24.7	24.7	45	45	35.7	54.5
Chloride	230,000	mg/L	10.1	10.1	9.8	9.8	9.9	12.2
Fluoride	NA	mg/L	0.19	0.19	0.19	0.19	0.19	1.2
Hardness	NA	mg/L	101	101	524	524	237	487
Sulfate	NA	mg/L	9.3	9.3	418	418	139	202
Metals Total								
Aluminum	125	µg/L	**174.2**	**174.2**	**163.8**	**163.8**	**166.7**	**165.6**
Antimony	31	µg/L	0.32	0.32	0.3	0.3	7.8	0.29
Arsenic	53	µg/L	1.0	1.0	1.1	1.1	5.3	1.8
Barium	NA	µg/L	49	49	37.6	37.6	37	83.1
Beryllium	NA	µg/L	0.2	0.2	0.18	0.18	0.28	0.2
Boron	500	µg/L	27.1	27.1	77.1	77.1	136.4	212.7
Cadmium	1.4 – 9.03(1)	µg/L	0.13	0.13	0.12	0.12	0.95	0.13
Chromium	11	µg/L	2.3	2.3	2.19	2.2	4.0	2.2
Cobalt	5	µg/L	0.91	0.91	0.88	0.88	2.6	1.6
Copper	5.018 – 38.4(1)	µg/L	2.8	2.8	2.6	2.6	5.7	2.7
Iron	NA	µg/L	3,697	3,697	3,485	3,485	3,537	3,586
Lead	1.32 – 26.2(1)	µg/L	0.76	0.76	0.72	0.72	1.6	0.75
Magnesium	NA	µg/L	10,342	10,342	101,190	101,190	38,508	86,525
Manganese	NA	µg/L	445	445	561	561	406	716
Nickel	29.1 – 211.6(1)	µg/L	4.0	4.0	4.0	4.0	26.4	4.5
Potassium	NA	µg/L	1,626	1,626	21,256	21,256	7,455	9,637
Selenium	5	µg/L	1.3	1.3	1.3	1.3	2.7	1.3
Silver	1	µg/L	0.13	0.13	0.13	0.13	0.14	0.13
Sodium	NA	µg/L	4,433	4,433	37,683	37,683	14,730	37,121
Thallium	0.56	µg/L	0.26	0.26	0.25	0.25	0.25	0.25
Vanadium	NA	µg/L	5.6	5.6	5.7	5.7	7.2	5.4
Zinc	66.9 – 221.2(1)	µg/L	18.6	18.6	17.5	17.5	55.9	17.8

Source: PolyMet 2013j.

1 Range associated with varying hardness; exact numbers vary with modeled hardness at evaluation location.
Note: Bold numbers indicate exceedances of the evaluation criteria at the P90 modeled concentrations.

Aluminum in Surface Waters of the Embarrass River Watershed

As shown in Tables 5.2.2-45 and 5.2.2-46, a scan of model results over the 500-year simulation period indicates that maximum P90 aluminum concentrations at most of the evaluation locations for both the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative exceeds the evaluation criterion of 125 µg/L. For example, Embarrass River location PM-12, which is upstream of any NorthMet Project Proposed Action effects, has a maximum P90 concentration of 173.8 µg/L. Concentrations of aluminum for the NorthMet Project No Action Alternative conditions at tributary locations MLC-2, MLC-3, TC-1, PM-19, and PM-11 are lower than at PM-12, averaging about 136 µg/L, but still above the evaluation criterion. Concentrations for NorthMet Project Proposed Action conditions in the tributaries increase over NorthMet Project No Action Alternative conditions by an average of about 20 percent, which results in a corresponding increase in the Embarrass River at PM-13 of up to a maximum of nearly 3 percent. The causes of these increases are discussed below.

The relative concentrations of aluminum vary across the various sources of water:

- ambient groundwater – 50 to 90 µg/L;
- ambient surface water – 70 to 150 µg/L (30 percent probability of exceeding the evaluation criterion of 125 µg/L); and
- Tailings Basin seepage – 5 to 20 µg/L.

Under NorthMet Project No Action Alternative conditions, the relatively low aluminum concentration in LTVSMC Tailings Basin seepage, which constitutes about 30 percent of total flow to the tributary streams (see Table 5.2.2-42), mixes with and dilutes ambient groundwater and surface water with higher aluminum concentrations. This dilution effect is demonstrated by the increase in aluminum concentration from upstream tributary locations (UC-1, TC-1, and MLC-3) to downstream locations (PM-11, PM-19, and MLC-2), where upstream locations average less than 100 µg/L compared to downstream locations averaging about 142 µg/L.

Under NorthMet Project Proposed Action conditions, virtually all of the existing seepage would be captured by the groundwater containment system, pumped to the WWTP, treated, and then discharged to these tributary streams at a predicted aluminum concentration of 20 µg/L, in combination with Colby Lake water (as part of the proposed flow augmentation measure), which has aluminum concentrations ranging from about 70 to 160 µg/L. This loss of Tailings Basin seepage, which was serving to dilute ambient aluminum concentrations, and replacement with higher aluminum concentration WWTP and/or Colby Lake water is predicted to increase aluminum P90 values for the NorthMet Project Proposed Action. A mix of the two augmentation sources would be used during operations (first 20 years), all Colby Lake water during filling of the West Pit (years 21 to 33), and all WWTP effluent during long-term closure (after 33 years). The relative effects of these different sources of water during different mine phases on P90 aluminum concentrations in the tributary streams and in the Embarrass River (PM-13) are shown in Table 5.2.2-47.

Table 5.2.2-47 Maximum P90 Aluminum Concentrations (µg/L) for Embarrass River Tributaries and Embarrass River for Various Conditions

Location	No Action Conditions[1]	NorthMet Proposed Action Conditions		
		Operations (Years 1–20)	Reclamation (Years 21–40)	Closure (After Year 40)
MLC-3	139-144	168	171	176
TC-1	106-113	148	151	112
PM-11	137-143	157	161	150
PM-13	159-166	161	163	163

Source: PolyMet 2013j.

[1] P90 values vary slightly depending on time period.

Aluminum concentration in Mud Lake Creek would not change appreciably during any NorthMet Project Proposed Action time period because water quality in that stream, after the Mud Lake Creek Diversion occurs (year 7), is controlled primarily by natural runoff (no augmentation). Aluminum in the other two tributaries reaches maximum concentrations during reclamation when all WWTP effluent is pumped to the Mine Site to help fill the West Pit, so 100 percent of stream augmentation water would come from Colby Lake with relatively high aluminum concentrations. In the long term, when only WWTP effluent is used for augmentation, the maximum P90 values for Trimble Creek, Unnamed Creek, and the Embarrass River would all decrease. The reason the concentrations do not decrease even more, considering that Colby Lake water would no longer be used, is that the seepage rate from the Tailings Basin would be decreasing once operations cease resulting in reduced WWTP flows, and therefore less water available to dilute ambient groundwater and surface water with higher aluminum concentrations. During closure for the NorthMet Project Proposed Action, aluminum concentrations at TC-1 would increase less than 1 percent over NorthMet Project No Action Alternative conditions and the value at PM-11 would increase less than 5 percent. The net effect of these tributary changes on Embarrass River at PM-13 is less than a 1 percent increase in aluminum concentration.

In summary, these predicted increases in aluminum are not the result of increased aluminum loadings from the NorthMet Project Proposed Action, but rather the result of diverting low concentration Tailings Basin seepage, which serves to dilute higher concentration ambient groundwater and surface water, and replacing it, at least partially, with higher concentration Colby Lake water.

Lead in Surface Water at the Tailings Basin

Model results for the Plant Site indicate that the NorthMet Project Proposed Action may exceed the surface water evaluation criteria for lead in Unnamed Creek and Trimble Creek.

The existing LTVSMC Tailings Basin seepage is relatively high in hardness and associated solutes such as calcium, magnesium, potassium, and sodium, as shown by the No Action values for the tributaries in Table 5.2.2-45, with P90 hardness values for the tributaries (MLC-2, MLC-3, TC-1, and PM-11) consistently being well above 400 mg/L. In comparison, the P90 hardness value at PM-12, upstream of any NorthMet Project Proposed Action effects, is 101.1 mg/L.

The surface water evaluation criteria for lead are hardness-based. Because hardness is very high in the tributaries (because of seepage from the Tailings Basin) under existing conditions, the water quality evaluation criterion for lead is also quite high. Under NorthMet Project Proposed

Action conditions, most seepage from the Tailings Basin is collected, treated by the WWTP, and released to Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek with significantly (over 50 percent) less hardness. This, in turn, significantly decreases the hardness in the tributaries, which causes the hardness-based water quality evaluation criteria to be lower in the tributaries than under existing conditions. Although cadmium, copper, lead, nickel, and zinc all have hardness-based evaluation criteria, only lead is predicted to exceed its evaluation criteria for the NorthMet Project Proposed Action and only at Unnamed Creek and Trimble Creek.

The modeled exceedances in these tributaries, however, are primarily caused by natural conditions, not by the NorthMet Project Proposed Action. The primary sources of water to these surface water evaluation locations are background water (groundwater and surface runoff) and the NorthMet Project Proposed Action (i.e., seepage from the Tailings Basin, WWTP effluent).

- Natural background groundwater – background lead (0.15 to 0.4 μg/L) groundwater concentrations are well below what would be the surface water quality evaluation criterion over the range of estimated hardness (3.0 to 5.3 μg/L for lead). Therefore, the predicted exceedances in lead are not attributable to background groundwater concentrations.
- Natural background surface runoff – natural runoff from undisturbed portions of the watersheds is estimated to occasionally exceed the surface water evaluation criterion for lead (i.e., at any given time, there is approximately a 10 percent chance that the lead surface runoff concentration would exceed the associated lead evaluation criterion).
- Seepage from the Tailings Basin – most (greater than 90 percent) seepage from the Tailings Basin is collected via the groundwater containment system, treated by the WWTP, and discharged to these four tributaries.
- NorthMet Project WWTP effluent – would comply with the lead evaluation criteria over the estimated range of hardness.

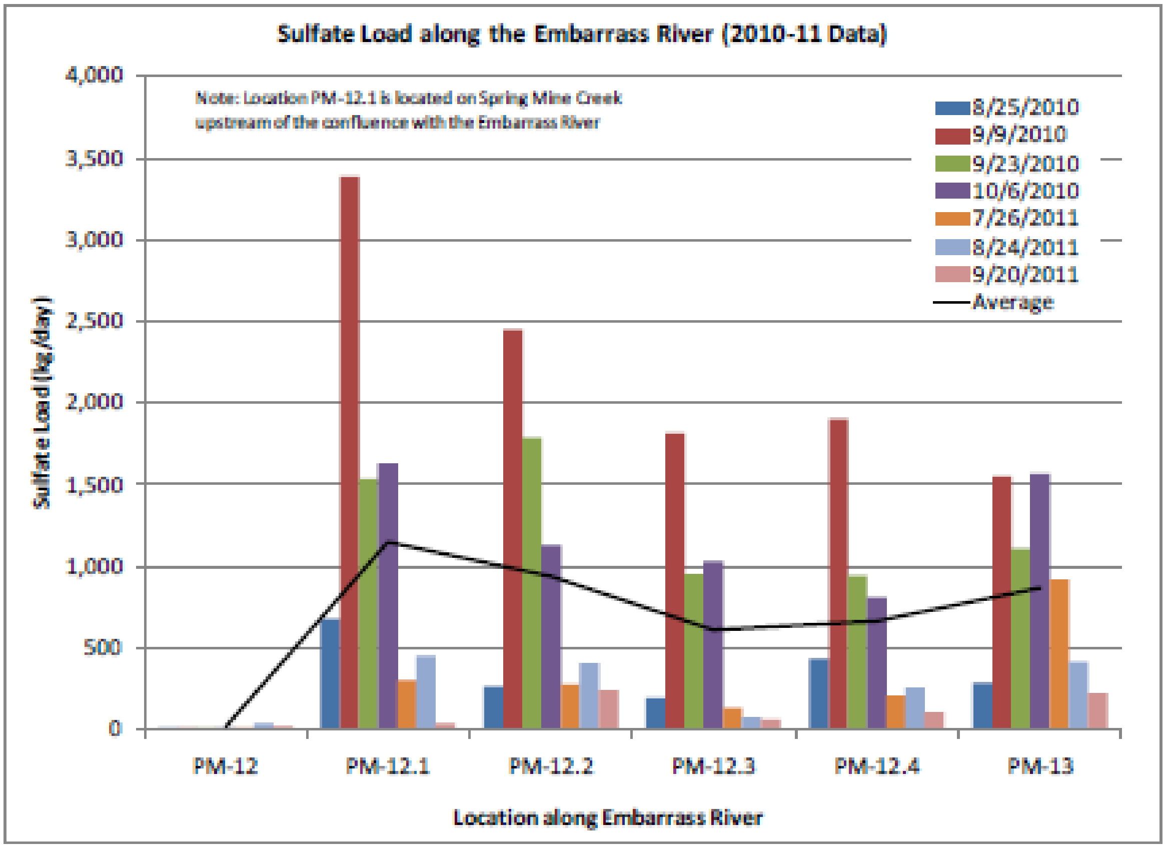
Therefore, these predicted exceedances of the evaluation criteria are primarily attributable to surface runoff, especially during high flows when surface runoff dominates flow at the surface water evaluation locations. In fact, the modeling indicates that by directing the WWTP discharge and Colby Lake water to these tributaries as proposed by PolyMet, there would be a lower probability of an exceedance than if only natural runoff and unaffected groundwater reaches these tributaries.

In summary, the NorthMet Project Proposed Action's containment system would capture virtually all of the high-hardness seepage from the Tailings Basin, which would cause the hardness-based lead water quality evaluation criterion in the tributaries to significantly decrease. The capture and treatment of existing high-hardness seepage (affected by the existing LTVSMC Tailings Basin seepage) combined with the probability of elevated lead concentrations in natural surface runoff causes the NorthMet Project Proposed Action model to show an increased frequency of exceedances in surface water. However, the root cause of the exceedances is not directly from NorthMet Project Proposed Action discharges. NorthMet Project Proposed Action discharges from the WWTP would meet the applicable evaluation criteria. The increased frequency of exceedances would be attributable to the relatively high concentrations of lead in natural surface runoff combined with lower lead water quality evaluation criteria because of lowered hardness.

Sulfate in Surface Water in the Embarrass River

The effect of the NorthMet Project Proposed Action on sulfate concentrations in the Embarrass River Watershed is of concern because of the presence of waters used for the production of wild rice downstream in Embarrass Lake, the northernmost tip of Wynne Lake, and the segment of the Embarrass River from Sabine Lake to the Highway 135 bridge (Figure 5.2.2-1). Sulfate concentrations in these wild rice waters already exceed the 10 mg/L evaluation criterion. Seepage from the existing LTVSMC Tailings Basin, which averages about 228 mg/L, contributes to these elevated sulfate concentrations.

Although the sulfate load from the existing LTVSMC Tailings Basin is relatively high, not all of this sulfate actually reaches the Embarrass River. Concurrent monitoring at multiple locations along the Embarrass River document decreasing sulfate loads, which suggest biological sulfate reduction or losses. The average sulfate load in the Embarrass River between PM-12.3 and PM-13 increased by approximately 200 kg/day (Figure 5.2.2-47), but this is much less than the approximately 3,120 kg/day currently estimated to be seeping from the existing LTVSMC Tailings Basin towards the Embarrass River (sum of the loads leaving the North, Northwest, and West toes of the Tailings Basin; see PolyMet 2013l). Concurrent monitoring of chloride clearly shows that Tailings Basin seepage is reaching the Embarrass River (Figure 5.2.2-48). The GoldSim model does not capture these sulfate reductions, resulting in overestimation of existing and future sulfate concentrations. Therefore, consistency with the evaluation criteria was assessed by comparing the predicted sulfate concentrations for the NorthMet Project Proposed Action with the NorthMet Project No Action Alternative at key evaluation locations like PM-13, which is the most downstream evaluation location and which captures all NorthMet Project Proposed Action-related contaminant loadings.



Source: Barr 2013j.

Figure 5.2.2-47 Sulfate Load Calculated Along the Embarrass River (2010-2011)

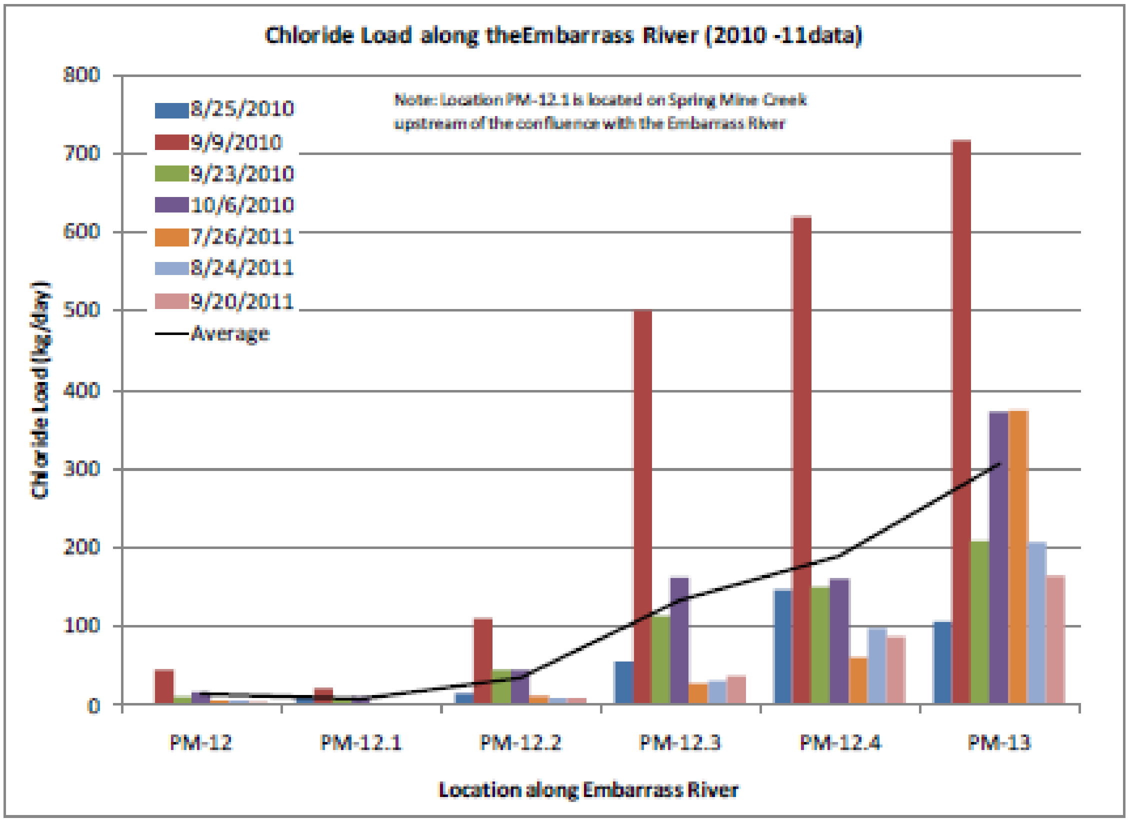
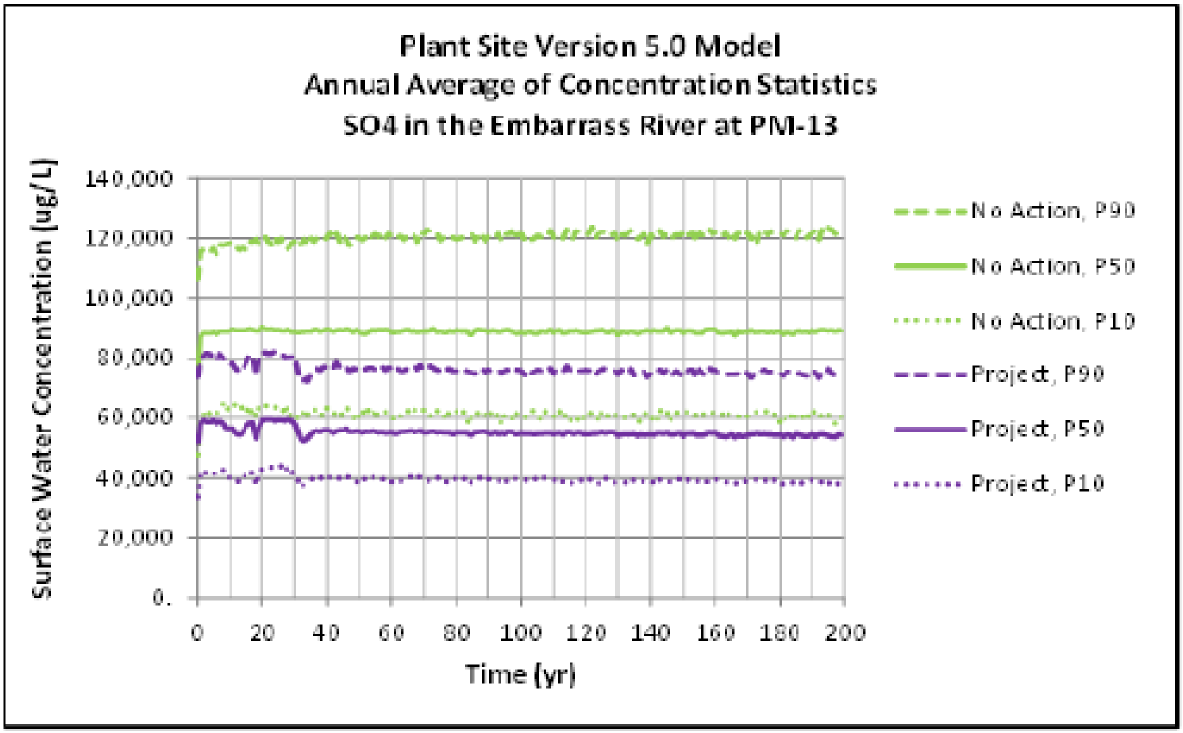


Figure 5.2.2-48 Chloride Load Calculated Along the Embarrass River (2010-2011)

As Figure 5.2.2-49 shows, the annual average P90 sulfate concentration at PM-13 for the NorthMet Project Proposed Action is predicted to be consistently less than the predicted concentrations for the NorthMet Project No Action Alternative. This reduction in sulfate loadings is attributable to the proposed engineering controls that would collect and treat most seepage from the groundwater containment system and provide a bentonite amended Tailings Basin cover at closure.



Source: Barr 2013j.

Figure 5.2.2-49 Annual Average Sulfate Concentrations in the Embarrass River at PM-13

5.2.2.3.4 Mercury

Mercury can be released to surface water or groundwater through mobilization of mercury stored in rock, soil, peat, and vegetation. Methylmercury is the 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 concentration perspective; the potential effects of the NorthMet Project Proposed Action on the bioaccumulation of methylmercury in fish are discussed in Section 5.2.6.

Mercury was not included in the GoldSim model as insufficient data and a general lack of definitive understanding of mercury dynamics prevented modeling mercury like the other solutes. Nevertheless, the NorthMet Project Proposed Action still needs to demonstrate consistency with the mercury evaluation criteria (Section 5.2.2.1).

Direct Release of Mercury to the Partridge River Watershed

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 (SRK 2007b). 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 (SRK 2007b). Therefore, the data suggest that mercury present in rainfall or released by sulfide oxidation is typically adsorbed 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. The primary NorthMet Project Proposed Action-related source of mercury to the Partridge River is the West Pit discharge.

As discussed previously, there would be no surface water discharges to the Partridge River or its tributaries from the Mine Site until approximately year 40, when the West Pit floods and the overflow would be directed to the WWTF for treatment and discharge. The West Pit overflow would be considered a discharge and be subject to the Great Lakes Initiative standard for mercury (1.3 ng/L). Mercury concentrations in the West Pit were estimated two ways: using analog data from other natural lakes and mine pit lakes in northeastern Minnesota and using a mass balance approach.

The West Pit, like seepage/headwater lakes (e.g., lakes with no significant inflowing streams), receives most of its water from precipitation and direct runoff from the surrounding watershed. Water balance modeling estimates that 70 percent of the West Pit inflow after reclamation would be from precipitation. Therefore, natural seepage/headwater lakes and existing mine pits in the vicinity of the NorthMet Project area can provide an analog for mercury concentrations in the West Pit at the time of overflow. Data from 16 mine pit lakes and five natural headwater/seepage lakes in northeastern Minnesota were evaluated. As Table 5.2.2-48 shows, despite the fact that the primary source of inflow to these lakes/pits was precipitation, which averages 10 to 13 ng/L, only two of the lakes/pits had average total mercury concentrations above the Great Lakes standard of 1.3 ng/L (Pit 2W at 1.61 ng/L and Pit 9S at 1.87 ng/L).

Table 5.2.2-48 Total Mercury Concentration Data from Natural Lakes and Mine Pits in Northeastern Minnesota

Lakes/Pits	Number	Total Mercury Average Range	Individual Sample Range	Number with Avg Concentration >1.3 ng/L
Natural Lakes	5	0.43 – 1.25 ng/L	0.34 – 1.73	0
Pit Lakes	21	0.4 – 1.87 ng/L	0.5 – 2.55	2

Source: PolyMet 2013i.

A mass balance approach was also used to evaluate potential mercury concentrations in the West Pit. The mass balance took into consideration average inflows and estimated potential mercury inputs from precipitation, atmospheric dry deposition, groundwater inflow, Category 1 Stockpile drainage, other stormwater runoff within the Mine Site, supplemental water from the Plant Site WWTP, collected seepage from the Tailings Basin, and inflows from the East Pit (Table 5.2.2-49). The mass balance also took into consideration the loss of mercury via burial (i.e., loss due to settling), evasion/volatilization, and outflow (i.e., pumping to the WWTF for treatment and discharge). The mass balance model conservatively assumes that mixing only occurs in the upper 30 ft of the water column, as this limits the volume of water available to dilute the mercury loading.

Table 5.2.2-49 Initial and Final Parameter Values for the Mercury Mass Balance

Parameter	Flow in Mine Year 45	Total Mercury Concentration or Flux
Wet and Dry Deposition Precipitation (based on monitoring data) (1) Atmospheric dry deposition Total wet and dry deposition	696 acre-ft/yr (1) NA NA	13 ng/L; 9,407 ng/m2/yr (1) 3,093 ng/m2/yr (1) 12,500 ng/m2/yr (1)
Contained/Uncontained Category 1 Stockpile drainage	0.3 ac-ft/yr (2)	13 ng/L
Watershed runoff (stormwater runoff from undisturbed or reclaimed/revegetated areas; includes the runoff from the Category 1 stockpile)	30 ac-ft/yr (2)	4 ng/L (3)
Groundwater Inflow (shallow aquifer)	46 ac-ft/yr (2)	3 ng/L (3)
East Pit flow (from wetland)	239 ac-ft/yr (2)	4 ng/L
Backfilled East Pit flow (groundwater) (“lower pore water seepage”)	0 (2) (intermittent contribution; 0.02 to 0.15 ac-ft/yr)	4 ng/L
Treated Water: Mine Site Wastewater Treatment Facility	0 (2) (Up to 453 acre-ft/ yr during pit flooding)	8 ng/L
Plant Site Water: Treated water from the WWTP and collected seepage water (untreated) from the groundwater containment system and South Seepage management system (supplemental water for pit flooding)	0 (2) (Up to 6,600 acre-ft/yr during pit flooding)	1.3 ng/L
West Pit Mercury Losses		
Burial	NA	92% of total load; 12.6 ng/m2/yr (4)
Evasion/Volatilization (~5% of atmospheric inputs)	NA	5% of atmospheric inputs (5)
Outflows	490 acre-ft/yr (2)	Varies with concentration of West Pit water column

Source: PolyMet 2013i, Table 6-25.

1 Precipitation volume from monitoring stations within 30 miles of the Project; annual average Hg concentration from the National Atmospheric Deposition Program for the Fernberg Road Site (MN18) (2010-2011). Total atmospheric deposition is assumed to equal 12,500 ng/m2/yr (Swain et al. 1992). Dry deposition is set equal to the difference between total and wet deposition and represents about 25% of total deposition.
2 Flow estimate from GoldSim Modeling results.
3 Estimate of Hg concentration based on Project data.
4 Burial rate for mercury is lower (more conservative) than initial estimate according to the burial regression equation discussed in Section 6.6.2.3.7 of PolyMet 2013i.
5 Volatilization rate is estimated based on the low end of the range of values discussed in Section 6.6.2.3.7 of PolyMet 2013i.

Based on the input values from Table 5.2.2-49 above, the estimated average mercury concentration of the West Pit during flooding (years 20 to 40) would be approximately 0.3 ng/L and after flooding (after year 40) would stabilize at approximately 0.5 ng/L.

It should be noted that the West Pit overflow would be treated by the WWTF using RO technology prior to discharge, and the RO process is known to remove mercury. Therefore, the actual mercury concentrations in the WWTF effluent discharge are expected to be less than the concentrations predicted for the West Pit lake. Table 5.2.2-50 provides a summary of the initial mass balance results, with the largest input of mercury to the West Pit coming from atmospheric deposition (about 55 percent of total estimated inputs), and the largest loss of mercury attributed to burial (about 92 percent of total mercury inputs).

Table 5.2.2-50 Summary of Estimated Mercury Loading (Inputs)[(1)] and Losses (Outputs) for the West Pit Lake (Mine Year 20 to about Mine Year 40)

Parameters	Annual Average Load of Mercury (nanograms)	Percent of Summed Inputs	Comments
Inputs			
Atmospheric (wet + dry)	1.28E+10	56%	Dry deposition ~30% wet deposition
East Pit wetland overflow	5.15E+08	2%	Includes runoff from the East Pit watershed to the East Pit
Stormwater Runoff (other than from the East Pit)	1.66E+09	7%	Includes runoff from the Category 1Stockpile
Groundwater	2.74E+08	1%	Includes groundwater flow from undisturbed portions of the Mine Site + groundwater inflow from the East Pit + contained/ uncontained Category 1 Stockpile drainage
WWTF	2.88E+09	13%	
Pumping from the Plant Site: WWTP and collected seepage from the Tailings Basin	4.80E+09	21%	
SUM	2.29E+10		
Outputs (Losses)			
Evasion/Volatilization	6.40E+08	3%	Loss from the water column
Burial	2.11E+10	92%	
Groundwater	NE		
Overflow (discharge)	1.38E+07	0.1%	
Removal by RO WWTF	NE		
SUM	2.17E+10		
NET (retention)			
Inputs – Outputs	1.18E+09		Net retention of Hg

Source: PolyMet 2013i, Table 6-26.

NE = Not estimated for this analysis.

1 Reasonably conservative estimates of mercury concentrations and average annual flow estimates from GoldSim modeling were used to estimate mercury loading.

Direct Release of Mercury to the Embarrass River Watershed from the Tailings Basin

The Plant Site would receive inputs of mercury from two primary sources: residual trace concentrations in the tailings and process consumables, with some minor contributions from Colby Lake makeup water and Mine Site process water, which would be pumped to the Tailing Basin pond through year 11. Mercury would be released from the Tailings Basin via seepage, discharge from the WWTP, and volatilization from the Tailings Basin pond (this mechanism is discussed in Section 5.2.7, Air Quality). As with the Mine Site, mercury was not included in the GoldSim model, but quasi-analog and mass balance approaches were used to estimate future mercury concentrations.

Several studies have been conducted by state agencies regarding the release of mercury from taconite ore processing and tailings facilities. Berndt (2003) concluded that wet and dry deposition of mercury were the major source of dissolved mercury in taconite tailings pond water, rather than the actual tailings themselves. Further, Berndt 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 Northshore Mine) than in either precipitation input or pond water in the tailings basin. This finding is supported by surface and groundwater monitoring around the existing LTVSMC Tailings Basin, which found mercury concentrations consistent with baseline levels (Table 4.1-31), generally averaging less than 2.0 ng/L. The overall average total mercury concentration at two discharge locations at the Tailings Basin (SD026 and SD004) over a 5-year period was 1.1 ng/L, indicating relatively low mercury concentrations in the existing LTVSMC tailings basin seepage. All monitoring results were well below average concentrations in precipitation, so most mercury appears to be sequestered in the LTVSMC tailings.

A mass balance model was developed to aid in estimating potential release of mercury from the Plant Site. All major inputs of mercury were included in the mass balance model. The major outputs of mercury include the hydrometallurgical residue, air emissions from the hydrometallurgical process, the tailings, and the ore concentrate. The vast majority of the mercury is predicted to remain in the concentrate, with only about 8 percent predicted to be sent to the Tailings Basin via the tailings and process water. Process and tailings water samples from a pilot study conducted with NorthMet ore were found to have mercury concentrations 11.2 and 0.7 ng/L, respectively. Mercury loadings to the Tailings Basin are estimated to be about 16 lbs/yr, with about 15.8 lbs/yr from solids and about 0.4 lbs/yr from process water. This is significantly less than the 610 lbs/yr estimated average mercury loading to the existing LTVSMC tailings basin during LTVSMC operations.

NTS (2006) conducted a bench study using NorthMet tailings to determine the rate of mercury adsorption by the tailings. The concentration of dissolved mercury in a treatment flask containing process water and NorthMet tailings decreased from 3.3 ng/L (at time 0) to 0.9 ng/L (at 480 minutes). Although the exact mechanisms behind the adsorption process is not yet clearly understood, the ability of NorthMet tailings to adsorb mercury, in combination with the proven ability of the underlying taconite tailings to adsorb mercury, is expected to result in an overall increase in the adsorption of mercury at the Tailings Basin with the addition of the flotation tailings.

In summary, the Tailings Basin is predicted to receive less mercury (about 2 to 3 percent) and less flow than the existing LTVSMC Tailings Basin historically received, while retaining the adsorption benefits of the LTVSMC tailings as well as the demonstrated mercury adsorption capability of the NorthMet tailings. For these reasons, it is reasonable to conclude that the seepage from the NorthMet tailings should have similar or lower mercury concentrations as the LTVSMC tailings seepage, which have averaged about 1.1 ng/L. Therefore, the total mercury concentration in seepage from the Tailings Basin is expected to be less than the Great Lakes Initiative standard of 1.3 ng/L.

Most of the Tailings Basin seepage would be captured by the tailings containment system and pumped to the WWTP for treatment. The WWTP would also receive water from the Tailings Basin pond, as well as stormwater runoff from the basin. The discharge from the WWTP, like the discharge from the WWTF, would be subject to the Great Lakes Initiative standard of 1.3 ng/L. The estimated mercury concentration and flow rate for each of these influent streams is shown in Table 5.2.2-51. As this table shows, the combined influent streams are estimated to have a mercury concentration of 1.3 ng/L, prior to treatment.

Table 5.2.2-51 Estimated Mercury Concentration of the Combined Inflows to the Plant Site WWTP

Stream	Flow Rate (gpm)	Mercury Concentration (ng/L)	Total Mercury Flow (ng/yr)
Seepage water	1,498	1.1	3.3E+09
Runoff (interacting with tailings)	294	1.1	6.4E+08
Runoff (not interacting with tailings)	72	3.5	5.0E+08
Tailings Basin Pond dewatering	365	2.0	1.5E+09
Combined stream	**2,229**	**1.3**	**5.9E+09**

Source: Table 6-13, PolyMet 2013j

The WWTP would use a greensand filtration process followed by RO technology. RO treatment plants are known to remove mercury, particularly when the influent to the RO system is pre-treated. Therefore, the total mercury concentration in the WWTP discharge is expected to meet the evaluation criteria of 1.3 ng/L.

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 (more than 95 percent) is organic methylmercury (Bloom 1992). Thus, methylation is a key step in bioaccumulation of mercury. Methylmercury is a product of the methylation of inorganic mercury 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, as described above, the NorthMet Project is expected to result in a negligible release of inorganic mercury to groundwater or surface waters and is predicted to meet the 1.3 ng/L discharge evaluation criteria, the potential effect of the NorthMet Project Proposed Action on mercury methylation must be evaluated.

There are several factors that appear to influence mercury methylation including total available mercury, organic carbon, temperature, micronutrients required by sulfate-reducing bacteria, sulfate loadings (over the range for which sulfate may be a limiting factor for sulfate reducing bacteria), and certain hydrologic conditions. Most of these the NorthMet Project Proposed Action is expected to have little or no effect on, but the effect of the NorthMet Project Proposed Action on two of these, sulfate concentrations and hydrologic conditions, warrant further discussion. These two potential effects are discussed below.

Sulfate Loadings

Research indicates that sulfate-reducing bacteria are the primary mercury methylators in aquatic systems, especially in wetlands (Compeau and Bartha 1985). Biologically available sulfate 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 limiting can therefore stimulate sulfate-reducing bacteria activity, leading to increased mercury methylation as the sulfate is consumed (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). Heyes et al. (2000) reported a significant positive correlation between methylmercury and sulfate in a poor fen (R2 = 0.765, p = 0.005) and in a bog (R2 = 0.865, p = 0.022). However, the relationship between sulfate concentration and methylmercury production is complicated. Branfireun and Roulet (2002) found a negative relationship between sulfate and methylmercury in a wetland, which they interpreted as showing that methylmercury production at that site was caused by the reduction of sulfate. Water may also 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). 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 MDNR found little, if any, correlation between total mercury 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 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.

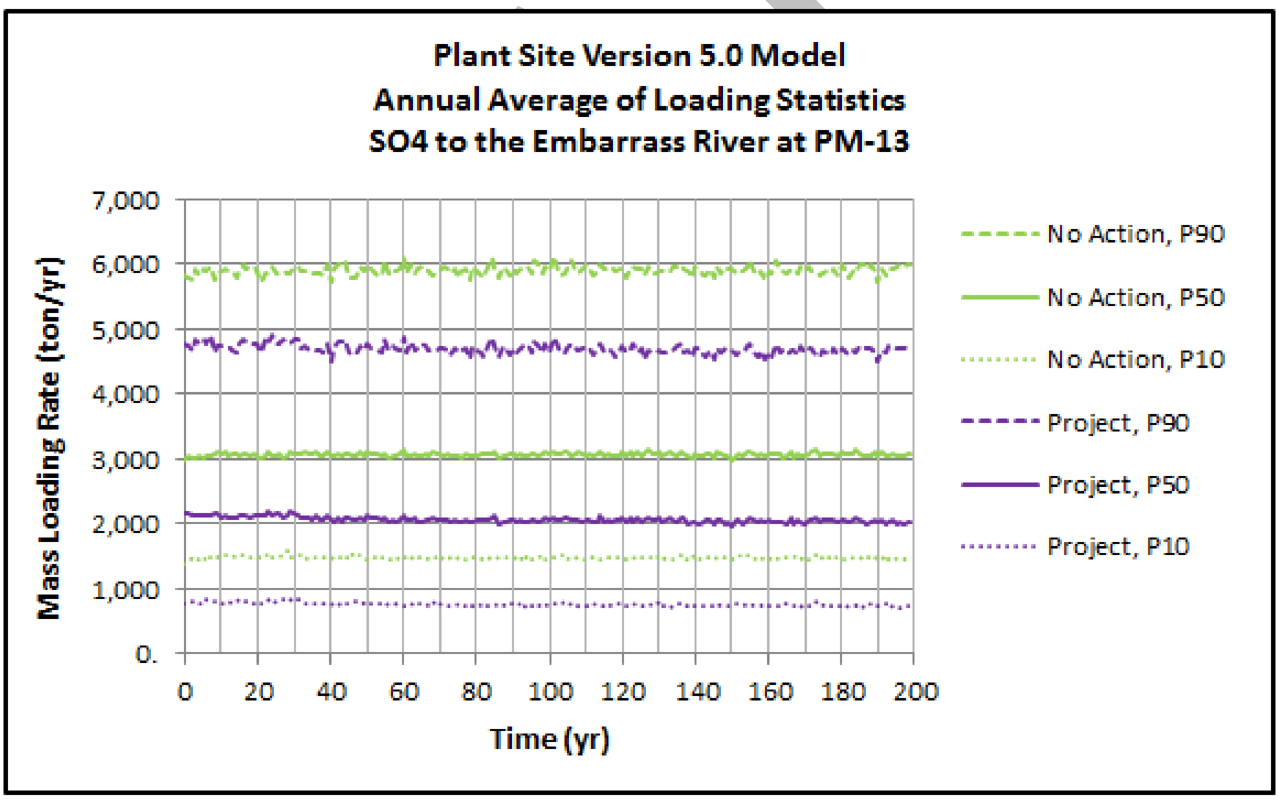
The MPCA recognizes the important role of sulfate in methylmercury production, as well as the uncertainties regarding site-specific relationships between sulfate discharges and waterbody impairment. The MPCA has set forth a strategy (2006) for addressing the effects of sulfate on methylmercury production that encompasses technical, policy, and permitting issues. The strategy acknowledges that the technical basis does not exist to establish sulfate concentration 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 effects 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 (less than 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 or most of which apply to the area downstream of the Tailings Basin and the WWTF discharge.

In response to this policy, as well as to comply with sulfate standards that apply to waters supporting the production of wild rice, PolyMet has proposed several significant changes to the

NorthMet Project design from that proposed in the DEIS that significantly reduce sulfate loadings, including a groundwater containment system around the Category 1 stockpile and a WWTF to treat the West Pit overflow at the Mine Site, and a groundwater containment system around most of the Tailings Basin and a WWTP to treat tailings seepage at the Plant Site.

As a result of the design changes at the Mine Site, the project is predicted to increase the sulfate load by less than 2 percent in the Partridge River watershed, but maintain the same maximum P90 concentration as the No Action Alternative (19.4 mg/L) and a maximum P50 concentration of only 14.4 mg/L. Effluent from the WWTF would be discharged at 9 mg/L beginning when the West Pit is predicted to flood in year 40. Sulfate concentrations in this range would meet the state's definition of low-sulfate water and would not be expected to promote mercury methylation.

As a result of the design changes at the Plant Site, the Project is predicted to significantly decrease sulfate loadings to the wetlands north of the Tailings Basin and to the Embarrass River, primarily because the groundwater containment system captures nearly all Tailings Basin seepage and routes it ultimately to the WWTP, which treats the seepage and discharges the effluent at a target concentration of 10 mg/L as part of the tributary streams flow augmentation. The net effect of these engineering controls would be a reduction in sulfate loadings relative to the NorthMet Project No Action Alternative at PM-13 (Figure 5.2.2-50).



Source: Barr 2013j.

Figure 5.2.2-50 Range of Annual Sulfate Loading Rates to the Embarrass River at PM-13; Existing versus NorthMet Project Proposed Action

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.

As discussed previously, the NorthMet Project would have minor effects on flows in the Partridge or Embarrass rivers, or their tributaries, and would not be expected to result in increases in flow fluctuations that can promote mercury methylation.

Summary

Based on the above analysis, the NorthMet Project Proposed Action would have negligible effects on hydrologic changes or water level fluctuations in the Partridge and Embarrass watersheds, would maintain relatively low sulfate loadings and concentrations to the Partridge River, and would significantly reduce sulfate loadings to the Embarrass River. Overall, the NorthMet Project is not expected to increase the potential for mercury methylation either at the NorthMet Project area or downstream in the Partridge River, Embarrass River, or St. Louis River; in fact the project could be expected to reduce mercury methylation because of the overall significant reduction in sulfate loadings relative to existing conditions.

5.2.2.3.5 Proposed and Recommended Mitigation Measures

PolyMet has agreed to the following mitigation measures, which are considered part of the NorthMet Project Proposed Action and would have environmental benefits to water resources (PolyMet 2013c).

- Waste Rock Stockpile Liners – The temporary Category 2/3 Stockpile and Category 4 Stockpile, which have the potential to generate acid rock drainage, would have liner systems to capture water percolating through the stockpile.
- Subaqueous Disposal of Reactive Waste Rock – Starting in year 11, when mining in the East Pit ceases, the temporary Category 2/3 Stockpile and Category 4 Stockpile would be backfilled into the East Pit, and all future Category 2/3 and 4 waste rock would be placed in the East Pit or the Central Pit, once mining ceases in that pit. By placing Category 2/3 and 4 waste rock into the East Pit, which would be a subaqueous environment, the environmental effect associated with further oxidation and decomposition of sulfide minerals would be reduced.
- Also starting in year 11, some WWTF effluent would be sent to the East Pit to augment flooding as the pit is backfilled (the remainder of the effluent would continue to go to the Tailings Basin). The WWTF effluent would be used to produce a calcium carbonate slurry

that would be delivered to the East Pit to maintain circumneutral pH in the pit pore water as needed (PolyMet 2013g).

- The permanent Category 1 Stockpile, which does not have the potential to generate acid rock drainage, would have a groundwater containment system to collect stockpile drainage. A component of the containment system is a cutoff wall, which would be constructed by excavating a trench near the toe of the stockpile. Within the trench would be the drainage collection system, which would collect stockpile drainage and draw down the water table on the stockpile side of the cutoff wall, thereby maintaining an inward gradient along the cutoff wall and minimizing the potential for drainage passing through the cutoff wall. One component of this system would be a slotted or perforated horizontal drain pipe, which would have vertical risers extending upward into a process water ditch to collect surficial seeps and surface runoff, surrounded by aggregate within the trench. The trench would intercept stockpile drainage, collect it in the horizontal drain pipe, and convey it by gravity flow to collection sumps. From the northeast corner of the stockpile, a non-perforated pipe would convey the drainage to a collection sump, where it would be pumped to the WWTF. An additional section of the containment system would collect and convey drainage from the southwest corner of the stockpile to a second collection sump, where it would be pumped to the WWTF.
- A new containment system, which would be constructed along the north and west sides of the Tailing Basin, would be designed to capture virtually all of the Tailings Basin seepage presently flowing in those directions. It also includes utilization of an existing containment system along the south side of Tailings Basin Cell 1E. Seepage and local runoff captured by these systems would be pumped back into the Tailings Basin or to the Plant Site WWTP.
- Without flow augmentation, the groundwater containment systems would result in substantial reductions in flow to Second Creek (tributary to Partridge River), and Unnamed Creek, Trimble Creek, and Mud Lake Creek (tributaries to Embarrass River). The NorthMet Project Proposed Action includes flow augmentation from the WWTP, with additional water transferred from Colby Lake, when necessary, to comply with the recommendation from the MDNR to maintain surface flows within about plus or minus 20 percent of existing conditions in mining-affected streams in order to maintain existing aquatic ecology.
- The Hydrometallurgical Residue Facility would function as a large-scale sedimentation basin. The solids would settle out into the Hydrometallurgical Residue Facility, and the water would be returned to the Hydrometallurgical Plant for reuse. One benefit of this wet placement approach is a substantial reduction in fugitive dust emissions compared to a dry placement approach. The Hydrometallurgical Residue Facility would be a lined facility with a leakage collection system that returns any leachate to the Hydrometallurgical Residue Facility pond.

These mitigation measures are described in Section 3.2 and in detail in the NorthMet Project Description (PolyMet 2013c), Water Management Plans (PolyMet 2013e; 2013f), Residue Management Plan (PolyMet 2012e), and Water Modeling Data Package, Volume 2 – Plant Site, Version 9 (PolyMet 2013j).

Adaptive Engineering Controls

Adaptive engineering controls are elements of the NorthMet Project Proposed Action that, if justified, may be modified in design, operation, or maintenance before or after installation. Potential adaptive engineering controls, including non-mechanical treatment systems, at the Mine Site and Plant Site as well as contingency mitigation measures are briefly discussed below. Additional details on adaptive engineering controls and water resources objectives can be found in the NorthMet Project Adaptive Water Management Plan version 5 (PolyMet 2013g).

Mine Site

Wastewater Treatment Facility

The WWTF is considered an adaptive engineering control because the operating configuration and requirements of the process units within the WWTF or the capacity of the WWTF could be modified to accommodate varying influent streams and discharge requirements. The WWTF processes can be adapted depending on the actual water quality conditions encountered during the NorthMet Project Proposed Action phases and estimated by water quality monitoring and model updating (PolyMet 2013g).

Category 1 Stockpile Cover System

PolyMet proposes to install a geomembrane cover system to reduce the load of the constituents that reach the West Pit via drainage from the Category 1 Stockpile. Construction of the Category 1 Stockpile cover system would be progressive, starting in year 14 and being fully constructed by the end of year 21. Under the NorthMet Project Proposed Action, the Category 1 Stockpile would be the only permanent waste rock stockpile. Water quality modeling indicates that, for many constituents, this stockpile would be the largest source of constituent load to the West Pit. The Category 1 Stockpile cover system would be the primary engineering control that limits constituent loading from the Category 1 Stockpile to the West Pit. The design of the Category 1 Stockpile cover system could be adapted up to the point of construction, depending on the actual water quality conditions encountered during the NorthMet Project Proposed Action phases and estimated by water quality monitoring and model updating. After installation of the cover system, post-installation adjustments could be made (PolyMet 2013g).

Contingency Mitigation at the Mine Site

If monitoring or refined model estimates with adaptive engineering controls or modified adaptive engineering controls show that water quantity or quality at Mine Site evaluation locations would not meet compliance parameters, contingency mitigations could be implemented to address several situations, including (PolyMet 2013e):

- A pattern of overflows of the process water sumps or ponds develop – In all the process water sumps and ponds, there would be excess capacity designed as a safety factor ranging from approximately 30 to 270 percent of required capacity. Additional capacity could be developed by expanding the pond areas.
- Streams along the railroad corridor between the Mine Site and Plant Site show degradation in water quality as a result of material spilled from the rail cars – Catchment areas could be

developed adjacent to the tracks at stream crossings to minimize the amount of material that reaches the streams.

- Groundwater downgradient of lined infrastructure has compliance issues – Interception wells could collect groundwater flows affected by a leak from one of the liner systems. Because all liner systems at the Mine Site are for temporary infrastructure (temporary stockpiles, temporary ponds, etc.), the interception wells would only be needed while the liner is in use or until the liner repair could be performed.
- West Pit water quality is not as expected – This could be addressed by reducing the contaminant load from the West Pit walls or the East Pit using methods such as low permeability soil barriers or a PRB, adding water with lower concentrations of contaminates to the West Pit by routing additional stormwater to the West Pit, or treating the West Pit either by pumping West Pit water to the WWTF for treatment or treating the West Pit Lake in situ with iron salts, fertilizer, or other methods tailored to the contaminant.

Plant Site

Wastewater Treatment Plant

The WWTP is considered an adaptive engineering control because the operating configuration and requirements of the process units within the WWTP or the capacity of the WWTP could be modified to accommodate varying influent streams and discharge requirements. The WWTP processes can be adapted depending on the actual water quality conditions encountered during the NorthMet Project Proposed Action phases and estimated by water quality monitoring and model updating (PolyMet 2013g).

Tailings Basin Pond Bottom Cover System

PolyMet proposes to install a Tailings Basin Pond Bottom Cover System during reclamation in order to reduce the diffusion of oxygen into the tailings. The Tailings Basin Pond Bottom Cover System would consist of a bentonite amendment to the Tailings Basin Pond bottom to reduce percolation. This system would provide an oxygen barrier above the Flotation Tailings to reduce oxidation and resultant production of contaminants. In addition, the seepage through the tailings would be reduced resulting in less flow being collected via the Tailings Basin groundwater containment system and then treated.

Potential adaptive management actions for the Tailings Basin Pond Bottom Cover System could trigger design modifications if the monitored quantity or quality of water collected by the groundwater containment system suggests that modifications are needed to meet water resource objectives. The design of the Tailings Basin Pond Bottom Cover System can be adjusted to modify performance by several options, including increasing or decreasing the thickness of the bentonite amendment or excavating the bentonite amended tailings layer from portions of the pond bottom. Any design modifications would need to be approved by the MPCA and MDNR (PolyMet 2013g).

Contingency Mitigation at the Plant Site

If monitoring or refined model estimates with adaptive engineering controls or modified adaptive engineering controls show that water quantity or quality at Plant Site evaluation locations would not meet compliance parameters, contingency mitigations could be implemented to address several situations, including (PolyMet 2013f):

- New surface seepage locations emerge as the Tailings Basin is developed – The groundwater containment system or the Tailings Basin south surface seepage management system could be expanded to collect seepage from any new seepage locations.
- Tailings Basin pond water quality is worse than expected – This could be addressed by several methods, including: reducing solute load delivered to the Tailings Basin pond by incorporating additional treatment at the Mine Site WWTF; sending all or a portion of the water from the groundwater containment system and Tailings Basin south surface seepage management systems to the WWTP for treatment before being returned to the Tailings Basin pond; sending pond water to the WWTP for treatment before being returned to the Tailings Basin pond, or; treating the Tailings Basin pond in situ with iron salts, fertilizer, or other methods tailored to the constituent of concern.
- Groundwater or surface water downgradient of the Tailings Basin has compliance issues – This could be addressed by several methods including inspecting the containment system around the Tailings Basin for breaches and repaired or using interception wells to collect groundwater flows affected by a breach; improving Tailings Basin pond water quality (see above).

Non-mechanical Treatment Systems

The NorthMet Project Proposed Action would rely upon mechanical treatment to achieve water resource objectives as long as needed; however, the goal would be to transition to non-mechanical treatment—which is a low-maintenance, low-energy treatment system— to ensure attainment of water resources objectives, including compliance with applicable groundwater and surface water standards, during the closure phase. Non-mechanical treatment systems, which are described below, would be designed and pilot-tested before being implemented to treat water from the Category 1 Stockpile groundwater containment system, the West Pit Overflow, the Tailings Basin groundwater containment system, and the Tailings Basin South Seepage management system.

Category 1 Stockpile Groundwater Containment Non-mechanical Treatment System

PolyMet proposes to install a Category 1 Stockpile groundwater containment non-mechanical treatment system, which is a low-maintenance, low-energy non-mechanical treatment system, at the Mine Site to replace the mechanical treatment of the water collected by the containment system during the long-term closure phase of the NorthMet Project Proposed Action. The system would likely include two PRBs, which are flow-through treatment systems, for metal precipitation and solids removal. The PRBs would reduce constituent loading through physical, chemical, and/or biological treatment processes including: biochemical reduction of sulfate to sulfide using sulfate-reducing bacteria; sorption to solid phase surfaces such as iron oxides or organic matter; chemical precipitation to convert dissolved phase constituents to solid phase particles; and physical filtering of solid phase particles. The PRBs would ideally be located where they could take advantage of gravity flow. The locations are dependent on the final hydraulic plan for discharge from the Category 1 Stockpile groundwater containment system into the West Pit (PolyMet 2013g).

West Pit Overflow Non-mechanical Treatment System

PolyMet proposes to install a West Pit overflow non-mechanical treatment system at the Mine Site to replace mechanical treatment of the West Pit overflow water during the long-term closure phase of the NorthMet Project Proposed Action. It is expected to be a multi-stage system with a constructed wetland for metal (copper, cobalt, nickel, and lead) precipitation and solids removal, a permeable sorptive barrier (PSB) for metal sorption, and an aeration pond to provide time for water exiting the PSB to re-equilibrate with the atmosphere and to increase the concentration of dissolved oxygen before the water is discharged. The West Pit overflow non-mechanical treatment system would be designed to discharge only during September and October in order to comply with the seasonal sulfate discharge criterion for wild rice downstream of the Mine Site. The 2-month discharge period would result in a higher flow rate and larger treatment system than would be required for continuous discharge (PolyMet 2013g).

Flotation Tailings Basin (Tailings Basin) Non-mechanical Treatment System

PolyMet proposes to install a Tailings Basin non-mechanical treatment system to replace the mechanical treatment of the water draining through the Tailings Basin and collected in the Tailings Basin groundwater containment system and the South Seepage management system during the long-term closure phase of the NorthMet Project Proposed Action. The Tailings Basin non-mechanical treatment system would consist of a constructed wetland for metal precipitation, sulfate load reduction, and solids removal and PSBs for polishing (additional removal of metals, if needed). It would be constructed by rebuilding the natural wetlands between the Tailings Basin and the containment system as a vertical, upflow constructed wetland system with PSB systems at the outer perimeter within the access road. The total flow for the Tailings Basin non-mechanical treatment system is expected to be 1,200 gpm, which would include flows at the north, northwest, west, and south toes (PolyMet 2013g).

Flotation Tailings Basin (Tailings Basin) Pond Overflow Post-mechanical Treatment Options

During the initial portion of the long-term closure period, Tailings Basin pond water would be pumped to the WWTP to prevent overflow. A monitoring program would document changes in pond water levels and water quality over time. One goal of the NorthMet Project Proposed Action during long-term closure is to allow overflow of the tailings pond. This could only be done after demonstrating that water in the Tailings pond is stormwater and that it complies with applicable standards. The Tailings Basin closure overflow structure would be embedded into bedrock of the hillside east of Cell 2E during reclamation. This structure would likely be modified to serve as a stormwater overflow, which would allow water discharged to enter the Mud Lake Creek Watershed (PolyMet 2013g).

5.2.2.3.6 Monitoring

Monitoring is critical component for ensuring that the proposed adaptive management would be effective. The NorthMet Project Proposed Action includes a water quality and quantity monitoring plan that would be finalized in permitting and updated as required. Overviews of the water monitoring plans at the Mine Site and Plant Site, with recommended or potential monitoring locations and frequencies, are presented in Tables 5.2.2-52 and 5.2.2-53. In addition, see Section 4.1.3.5 for a discussion of recommended monitoring measures for stormwater runoff.

Mine Site

Water monitoring at the Mine Site would be used to document compliance with permit conditions, validate and update water models, and provide input to optimize operations of adaptive engineering controls. Depending on the component (i.e., water flow, elevation, or quality) monitoring frequency would range from continuously to quarterly (PolyMet 2013e). An overview of the water monitoring plan at the Mine Site, which would be finalized in permitting, is in Table 5.2.2-52.

Table 5.2.2-52 Overview of Monitoring Plans at Mine Site (from PolyMet 2012)

Monitoring Plan	Component	Purpose	Summary	General Locations
Internal Process Water Streams	Pit Water	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in pit water quality.	Flow monitoring and water quality sampling[1]	Stations installed to monitor flows and water quality from each pit sumps
	Stockpile Drainage	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in stockpile drainage water quality.	Flow monitoring and water quality sampling[1]	Stations installed to monitor drainage from each stockpile liner, each stockpile underlain and the two Category 1 Stockpile groundwater containment system sumps
	Overburden Storage and Laydown Area Runoff	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in Overburden Storage and Laydown Area water quality.	Flow monitoring and water quality sampling of the Overburden Storage and Laydown Area pond[1]	Stations installed to monitor flows and water quality from the Overburden Storage and Laydown Area pond
	Haul Road Runoff	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in haul road water quality.	Flow monitoring and water quality sampling of the haul road ponds[1]	Stations installed to monitor flows and water quality from the haul road ponds
	Rail Transfer Hopper Runoff	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in RTH water quality.	Flow monitoring and water quality sampling of the RTH pond[1]	Stations installed to monitor flows and water quality from the Rail Transfer Hopper pond
	WWTF Influents and Effluents	Optimize the treatment operations and demonstrate acceptable effluent characteristics.	Flow monitoring and water quality sampling of the influent and effluent streams	Inlet and outlet of the WWTP

Monitoring Plan	Component	Purpose	Summary	General Locations
	TWP Flows	Compare water balance with expected conditions.	Flow monitoring and water quality sampling at the inlet and outlet	Inlet and outlet of the TWP
Stormwater	Stormwater	Evaluate trends in stormwater quality	Flow monitoring and water quality sampling at pond outlets[1]	Stormwater pond outlets
Groundwater	Surficial Aquifer	Evaluate groundwater level and water quality trends in the surficial aquifer.	Thirty-three sampling locations sampled approximately April, July, and October	Surficial aquifer monitoring wells installed downgradient of each stockpile and pit
	Bedrock	Evaluate groundwater level and water quality trends in the bedrock.	Number of wells are yet to be determined with sampling approximately April, July, and October	Bedrock monitoring well locations are yet to be determined
Wetlands	Wetlands	Evaluate water levels for potential effects of mining operations on wetlands and determine if the potential indirect effects from the mining operations have occurred or if additional mitigation is needed.	Number of piezometers and sampling frequency yet to be determined	Continuation of baseline monitoring program
Surface Water	Partridge River and Tributaries	Evaluate trends in surface water quality and flow	Flow monitoring at/near SW-004a and SW-006, and sampling of water quality at nine sampling locations during non-frozen conditions	Partridge River, Longnose Creek, Wetlegs Creek, Wyman Creek, and West Pit Overflow (when applicable)
	Colby Lake and Whitewater Reservoir	Evaluate trends in water quality of Colby Lake and water levels for Colby Lake and Whitewater Reservoir.	Water quality and water level sampling at one location for each waterbody during non-frozen conditions	Colby Lake and Whitewater Reservoir

Source: PolyMet 2013e; Liljegren, MDNR, Pers. Comm., 2013.

1 Water quantity monitoring would occur continuously based on flow meters or pump run times. Water quality monitoring would occur during non-frozen conditions.

Plant Site

Water monitoring at the Plant Site would be used to document compliance with permit conditions, validate and update water models, and provide input to optimize operations of adaptive engineering controls. Depending on the component (i.e., water flow, elevation, or quality) monitoring would occur continuously, monthly, or three times a year in the first month of non-freezing quarters (PolyMet 2013f). An overview of the water monitoring plan at the Plant Site, which would be finalized in permitting, is in Table 5.2.2-53.

Table 5.2.2-53 Overview of Monitoring Plans at Plant Site

Monitoring Plan Component		Purpose	Summary	General Locations
Internal Process Water Streams	Tailings Basin Pond	Monitor pond water levels and trends in Tailings Basin pond water characteristics over time	Water level (WL) monitoring and water quality (WQ) monitoring	WL monitoring location TBD; WQ monitoring at pond barge
	Tailings Basin Seepage	Evaluate seepage rate and trends in water quality characteristics over time	Flow monitoring and WQ samples from seepage collection systems	Groundwater containment system lift stations and Tailings Basin South Surface Seepage management system pump station
	Hydrometallurgical Residue Facility Pond	Monitor water level to prevent overtopping the Hydrometallurgical Residue Facility dam and monitor water quality trends over time	WL monitoring and WQ monitoring.	WL monitoring location TBD; WQ monitoring at pond barge
	Hydrometallurgical Residue Facility Leachate	Evaluate leachate quantity and characteristics over time.	Flow monitoring and monitoring of leachate quality	Underdrain
	Continued Existing Waste Streams	Continue existing NPDES monitoring requirements as appropriate	Monitoring of flow and WQ during non-frozen conditions (April, July, and October)	Seep into Cell 1E
Stormwater	Stormwater	Monitor stormwater quality and quantity	Flow rate (during non-frozen conditions, April through October) and WQ monitoring	Stormwater control features
Surface Discharges	WWTP	Demonstrate acceptable effluent characteristics	Flow and WQ monitoring of WWTP effluent, and total flow monitoring at discharge locations	WWTP Effluent

Monitoring Plan Component		Purpose	Summary	General Locations
Surface Water	Embarrass River and Tributaries	Evaluate trends in surface water quality and flow	Flow monitoring at/near PM-13 and PM-12 and WQ sampling	Embarrass River, Mud Lake Creek, Trimble Creek, and Unnamed Creek
	Second Creek	Evaluate trends in surface water quality and flow	Flow and WQ sampling	Second Creek downstream of seepage barrier
	Colby Lake Intake/discharges for augmentation	Evaluate water quantity use over time for plant use and to augment stream flow	Flow monitoring, total flow monitoring at discharge locations	Colby Lake intake/discharge system to Embarrass River tributaries and Second Creek
Groundwater	General	Evaluate groundwater quality and water level trends over time	Monitoring wells sampled during non-frozen conditions (April, July, and October)	Existing monitoring wells installed around the Tailings Basin

Source: PolyMet 2013f; Liljegren, MDNR, Pers. Comm., 2013.

WQ = Water quality

5.2.2.4 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and, therefore, the environmental effects associated with the Proposed Action, as described in Section 5.2.2, would not occur.

The GoldSim model was used to evaluate a No Action scenario, in addition to the NorthMet Proposed Action scenario. The results of the No Action modeling were used extensively for comparative purposes in evaluating the Proposed Action in Section 5.2.2. The No Action scenario represents future conditions without the NorthMet Project Proposed Action, including all existing facilities, such as the existing LTVSMC Tailings Basin. The existing LTVSMC Tailings Basin is represented in the GoldSim model prior to implementation of any mitigation measures that may be required of the current owner of the site. Due to the uncertainty in what mitigation measures would be necessary, they are not incorporated into the model. The No Action model uses the same model inputs as the Proposed Action model (exclusive of those that are specifically NorthMet Project Proposed Action-related).

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5.2.3 Wetlands

Summary

The NorthMet Project Proposed Action would result in both direct and indirect effects on wetland resources at the Mine Site, along the Transportation and Utility Corridor, at the Plant Site, and around the Mine Site (Area 1) and north of the Plant Site (Area 2). This section describes these effects within each of these areas and provides a summary over the operational life of the facility.

Direct wetland effects would result from mining-related activities that would result in filling, excavation, a combination of filling and excavation, and installation of a containment system within the wetland boundary. The NorthMet Project Proposed Action would directly affect 912.5 acres of wetlands located within the NorthMet Project area. The Mine Site would contain the majority of the direct wetland effects. The direct wetland effects within the NorthMet Project area would occur in the following wetland types: coniferous bog (56 percent), shrub swamp (12 percent), coniferous swamp (9 percent), shallow marsh (8 percent), deep marsh (8 percent), sedge/wet meadow (4 percent), hardwood swamp (1 percent), and open bog (1 percent). The majority of the direct effects would occur as a result of a combination of filling and excavation (65 percent).

Wetlands directly affected within the Mine Site would result in a combined effect area of 758.2 acres. These direct wetland effects would be caused by fill (10 percent), excavation (12 percent), or a combination of fill and excavation (78 percent). The Transportation and Utility Corridor would directly affect 7.2 acres of wetlands; all of which would be directly filled. Direct wetland effects within the Plant Site would result in effects on 147.1 acres. These wetlands effects would be caused by fill (12 percent), excavation (31 percent), excavation and fill (less than one percent), and the containment system (58 percent).

Compensatory mitigation is required for the 912.5 acres of wetlands that would be directly affected. The overall wetland mitigation strategy for the NorthMet Project Proposed Action is to replace unavoidable wetland effects in-kind where possible and in advance of effects when feasible. A combination of off- and on-site wetland mitigation projects would be implemented to fulfill the requirements for compensatory mitigation. PolyMet's current mitigation proposal includes the following:

- On-site mitigation totaling 101.8 acres of wetland restoration during reclamation.
- Off-site mitigation including:
  - Aitkin Site – 810.2 acres of wetland restoration and 123.1 acres of upland buffer;
  - Hinckley Site – 313.0 acres of wetland restoration and 79.2 acres of upland buffer; and
  - Zim Site – 508.2 acres of wetland restoration and preservation and 22.7 acres of upland buffer.

Off-site wetland compensation of 1,631.4 acres could provide 1,568.0 wetland mitigation credits. In addition, a total of 225.0 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 would be at a 4:1 ratio, resulting in an additional 56.3 credits.

The total off-site mitigation could provide 1,624.3 wetland mitigation credits. Compensatory ratios determined in permitting may vary from these assumptions. The determination of final mitigation credits suitable for USACE, MPCA, and MDNR purposes for offsetting effects due to the proposed NorthMet Project Proposed Action would be determined by the agencies during wetland permitting.

Finally, establishment of approximately 101.8 acres of wetland on site would likely occur during reclamation of the Mine Site and this establishment is not included in the mitigation credits discussed above.

Indirect wetland effects from the NorthMet Project Proposed Action would result from one of the following six factors: 1) wetland fragmentation, 2) change in wetland hydrology from changes in watershed area, 3) changes in wetland hydrology from groundwater drawdown, 4) water quality changes related to deposition of dust, 5) water quality changes related to ore spillage along the Transportation and Utility Corridor, and 6) changes in water quality related to leakage from stockpiles/mine features and seepage from mine pits. The change in wetland hydrology from groundwater drawdown at the Mine Site was assessed by two different methodologies; therefore, total indirect wetland effects were provided based on both approaches. The NorthMet Project Proposed Action would indirectly affect either approximately 7,413.1 acres of wetlands located within and around the NorthMet Project area based on the method of wetlands crossing analog impact zones or 6,498.1 acres of wetlands located within and around the NorthMet Project area based on the method of wetlands within analog impact zones. Mitigation for indirectly affected acres would be through monitoring and adaptive management, as discussed below. In order to determine if the NorthMet Project Proposed Action causes future wetland effects, wetlands would be monitored as required by the Section 401 WQC, CWA Section 404 permit, and WCA approval. Additional compensation may be required if determined necessary based on monitoring results. The monitoring plan would be based on those wetlands that have a high likelihood of indirect effects as a result of groundwater drawdown. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified during the annual reporting.

5.2.3.1 Methodology and Evaluation Criteria

Wetland effects for the NorthMet Project Proposed Action include direct, indirect, and cumulative effects. Effects were assessed using agency-prescribed methods as presented in the Wetland Analysis Work Plan (PolyMet 2011m) and using the wetland types and acreages identified in the report *NorthMet Project Baseline Wetland Typing Evaluation* (Barr 2011d). Methods used to evaluate direct and indirect effects are described below; cumulative effects are described in Chapter 6.

5.2.3.1.1 Potential Direct Wetland Effect Methodology and Evaluation Criteria

Direct wetland effects for the NorthMet Project Proposed Action were determined through a GIS analysis of the areas that would be directly disturbed by mining features and operations, such as mine pits, stockpiles, and access roads. The area of analysis for the direct effects included the Mine Site, Transportation and Utility Corridor, and Plant Site.

Direct effects would result from mining-related activities that would result in filling or excavation of wetlands. Wetlands within the NorthMet Project area were identified using the

Eggers and Reed (1997) community classification system, as described in Section 4.2.3. The analysis for the direct wetland effects included identification of wetland type, total wetland acreage, total acres of direct effect, type of direct effect (i.e., fill, excavation, etc.), and the quality of each wetland to be affected by the NorthMet Project Proposed Action.

5.2.3.1.2 Potential Indirect Wetland Effects Methodology and Evaluation Criteria

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 effect on the functions and values of remaining wetlands at the Mine Site include fragmentation from haul road construction; wetland fragmentation from NorthMet Project area elements such as open pits, stockpiles, and haul roads; and indirect hydrological effects that may result in a conversion of one wetland type to another or the conversion of a wetland to an upland. Other likely effects would result from dust accumulation, vehicle emissions, and noise (e.g., effects on wildlife). Other indirect effects could result from changes in wetland watershed areas (during operation and post-closure); groundwater drawdown resulting from open pit mine dewatering; groundwater mounding/drawdown resulting from operation of the Tailings Basin, including groundwater containment system; changes in stream flow near the Mine Site and Tailings Basin and associated effects on wetlands abutting the streams (during operation and post-closure); and changes in wetland water quality.

Indirect wetland effects were assessed using various models, some of which were associated with impact analysis of other environmental resources such as air, groundwater, and surface water that affect wetland resources.

Wetland acreage by wetland type was calculated using GIS analysis with 500-foot radius increments beginning at the mine pits and continuing out to a total radius of 10,000 feet (for a total of 20 increments); and 500-foot radius increments beginning at the Plant Site and continuing out to the Embarrass River. The area of analysis for the indirect effects extended beyond the NorthMet Project area component boundaries and included Area 1 and Area 2, as identified in Section 4.2.3. The analysis did not include wetlands identified as directly affected, and wetlands in the Northshore Mine and areas north have been excluded from the evaluation (PolyMet 2011m).

Noise and dust effects on wildlife that utilize the wetland habitat are discussed in Section 5.2.5 (Wildlife Section).

Additional description of the specific methods used to assess individual indirect effects is provided below.

Potential Indirect Wetland Effects Resulting from Wetland Fragmentation

For each wetland that would not be directly affected at the Mine Site, along the Transportation and Utility Corridor, or at the Plant Site, an estimate of potential indirect wetland effects (wetland acres by wetland type, and type of effect) from wetland fragmentation by NorthMet Project area features (e.g., open pits, stockpiles, haul roads) was determined based on an analysis of the various factors that may contribute to potential fragmentation such as change in the size of the wetland, the isolation of the wetland due to being surrounded by NorthMet Project are features, and the corresponding change in the function and values of the wetland (e.g., wildlife habitat). Fragmentation increases habitat edge effects (such as the introduction of non-native species), which are a function of habitat patch size and shape and the quality of adjacent landscapes.

Potential Indirect Wetland Effects Resulting from a Change in Watershed Area

For each wetland that would not be directly affected, but would have NorthMet Project area elements affected its watershed, an estimate of the change in watershed area (acreage and percent gain or loss) was calculated for the following conditions: pre-NorthMet Project Proposed Action, during operation when the maximum amount of watershed has been removed, and at closure. For those non-directly affected wetlands that would have changed watershed areas (during operation and post-closure), an estimate of potential indirect wetland effects (wetland acres by wetland type and type of indirect effect) was calculated.

Potential Indirect Wetland Effects Resulting from Changes in Hydrology

An estimate of potential indirect wetland effects (wetland acres by wetland type, and type of indirect effect) due to groundwater drawdown from open pit mine dewatering was determined using an analog model in which the degree of effect was correlated to the distance from the open pit mine (PolyMet 2011m). The surficial hydrogeology data is not sufficient for modeling groundwater drawdown contours in the bedrock and in the glacial aquifer at the Mine Site with a reasonable degree of certainty. Therefore, an analog approach was used based on similar mine settings (e.g., within the glacial till in the region). The closer a wetland was to the pit where dewatering would occur, the greater the water table drawdown would be and the greater the potential for hydrologic effects on overlying wetlands. Wetlands were divided into zones based on distance from the open pit. The analog distances, referenced to the pit edge, were as follows:

1. 0 to 1,000 ft;
2. greater than 1,000 to 2,000 ft;
3. greater than 2,000 to 3,500 ft; and
4. greater than 3,500 to 10,000 ft (within the wetland evaluation area).

The use of the potential impact zones may overestimate indirect effects on wetlands. Analog data were used instead of a model such as MODFLOW, since the data were based on regional and site-specific geologic data, engineering controls, and geologic settings, while MODFLOW could not practically be used due to complex mixes of fractured bedrock, glacial till, and wetland soils at the Mine Site (PolyMet 2013b). The Mine Site contains localized heterogeneous vertical and horizontal hydraulic conductivities within each soil unit, which also makes the MODFLOW model less effective. Hydraulic conductivities between the different deposits range from 0.00026 to 31 feet/day (PolyMet 2013b). Because there is such a wide range in hydraulic conductivity within the natural geologic formations at the Mine Site, each model layer would contain widely variable hydraulic conductivities. Thus, it was not feasible to model the expected effects of mine dewatering on wetlands in a meaningful way. Prior to conducting the analysis to identify potential indirect wetland effects resulting from changes in hydrology, bog wetlands within and surrounding the Mine Site were reclassified as either ombrotrophic or minerotrophic.

A discussion of potential indirect wetland hydrology drawdown effects, including conversion to other wetland community types, a change in vegetation without a change in community type, conversion to uplands, or other effects is provided below. These effects were categorized by applying the Eggers and Reed (1997) wetland classification system to each wetland type based on wetland sensitivity class tables for falling groundwater tables that were developed for a previously proposed mine project in Wisconsin (PolyMet 2013b).

Potential Indirect Wetland Effects Resulting from Changes in Hydrology

Potential indirect wetland effects from hydrological changes were evaluated based on estimates of groundwater upwelling and resulting surface water flow in wetlands and/or groundwater drawdown near the water containment system that would surround the Plant Site. An estimate of potential indirect wetland effects (wetland acres by wetland type, and type of effect) from hydrologic changes resulting from the containment system was determined as follows:

1. The amount of Plant Site groundwater seepage water that would evade the containment system and discharge to surface water features, including wetlands, downgradient of the Tailings Basin was quantified. A MODFLOW model developed for the Plant Site was used in conjunction with a GoldSim probabilistic model to estimate the quantity of seepage that would discharge to surface water features.
2. All wetlands (type, acreage) within the surficial aquifer groundwater flowpaths downgradient of the Plant Site were identified within the boundaries used in the water quality modeling (as shown in the Groundwater IAP Summary document [MDNR 2011q]).
3. Using the wetlands identified in step 2, wetlands were categorized into groundwater-fed and precipitation-fed wetlands using guidance in the Corps Memorandum (CEMVP-OP-R) *Distinguishing Between Bogs That Are Entirely Precipitation Driven Versus Those with Some Degree of Mineral Inputs from Groundwater and/or Surface Water Runoff* (Eggers 2011b) and evaluating the potential for indirect effects resulting from construction of the water containment system.

A discussion regarding potential indirect wetland hydrology effects, including conversion to other wetland community types, a change in vegetation without a change in community type, conversion to uplands, or other effects is provided below. These effects were categorized by applying the Eggers and Reed (1997) wetland classification system to each wetland type based on the wetland sensitivity class tables for rising groundwater tables that were developed for a previously proposed mine project in Wisconsin (PolyMet 2013b).

Potential Indirect Effects on Wetlands

An estimate of potential indirect wetland effects (wetland acres by wetland type and type of effect) was determined for wetlands abutting the following:

- the Partridge River, as a result of changes in river flow resulting from the NorthMet Project Proposed Action (during operation and post-closure); and
- the three creeks north and west of the Plant Site (Trimble Creek, Mud Lake Creek, and Unnamed Creek) and Second Creek south of the Plant Site, as a result of changes in stream flow resulting from operation of the Plant Site and containment system.

Changes in river and creek flow were determined from probabilistic water modeling, as described above.

Potential Indirect Wetland Effects Resulting from Water Quality Changes

A screening analysis was conducted that estimated potential annual deposition of dust, metals, and sulfur to wetlands within and adjacent to the Mine Site, Transportation and Utility Corridor, and Plant Site. The estimated deposition from fugitive dust emissions was used to identify wetlands that have the potential for water quality changes. An estimate of potential indirect wetland effects that would result from changes to water quality associated with fugitive dust emissions, metals and sulfide dust emissions, ore spillage, leakage from stockpiles and mine pits, and Tailings Basin groundwater seepage was estimated through air dispersion/deposition modeling (AERMOD). The receptors of interest were the wetlands that were not identified as directly affected.

5.2.3.2 NorthMet Project Proposed Action

The NorthMet Project Proposed Action would result in both direct and indirect effects. This section describes effects within the NorthMet Project area and provides a summary of wetland effects. Estimates of both direct and indirect wetland effects have changed during the EIS process as the result of refined analysis and changes in project design. The effects identified in this SDEIS are based on the most current information available and may differ from those identified in prior reports. Avoidance, minimization, mitigation, and monitoring measures for the NorthMet Project Proposed Action are discussed in Section 5.2.3.3.

5.2.3.2.1 Mine Site and Transportation and Utility Corridor Direct Wetland Effects

Direct wetland effects would result from the following Mite Site and Transportation and Utility Corridor components: construction and/or installation of the mine pits, Category 1 Stockpile, Category 2/3 Stockpile, Overburden Storage and Laydown Area, haul roads, rail transfer loadout, WWTF, perimeter dike, culverts, groundwater discharge pipe, groundwater containment system, stormwater collection ditches and ponds, CPS, process water pipes and ponds, TWP, transmission lines, and Dunka Road upgrades. The Mine Site features would result in 758.2 acres of directly affected wetlands (see Figure 5.2.3-1). Table 5.2.3-1 summarizes the directly affected wetlands within the Mine Site by community type while Table 5.2.3-2 identifies the activity that causes the effects expected at the Mine Site. Three wetland types comprise 89 percent of the expected wetland effects in the Mine Site, including 508.3 acres of coniferous bog (67 percent), 97.8 acres of shrub swamp (13 percent), and 70.3 acres of coniferous swamp (9 percent). Direct effects would be caused by fill (10 percent), excavation (12 percent), or a combination of fill and excavation (78 percent). The majority of the wetlands (99 percent) that would be directly affected wetlands are rated high quality, while 1 percent are rated as moderate quality (PolyMet 2013b).

Table 5.2.3-1 Total Projected Direct Wetland Effects at the Mine Site and the Transportation and Utility Corridor

	Directly Affected Wetlands at Mine Site			Directly Affected Wetlands at Transportation and Utility Corridor		
Eggers and Reed Class[1]	**Acres**	**%**	**No.**	**Acres**	**%**	**No.**
Coniferous bog	508.3	67	22	0.9	12	2
Coniferous swamp	70.3	9	7	1.6	22	7
Deep marsh	0.1	<1	1	0.0	0	0
Hardwood swamp	12.5	2	2	0.0	0	0
Open bog	4.8	1	4	0.0	0	0
Open Water (includes shallow, open water, and lakes)	0.0	0	0	0.0	0	0
Sedge/wet meadow	38.2	5	5	0.0	0	0
Shallow marsh	23.4	3	6	0.6	8	3
Shrub swamp (includes alder thicket and shrub-carr)	97.8	13	12	4.1	57	13
Total Direct Effects	758.2	100	59	7.2	100	25

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

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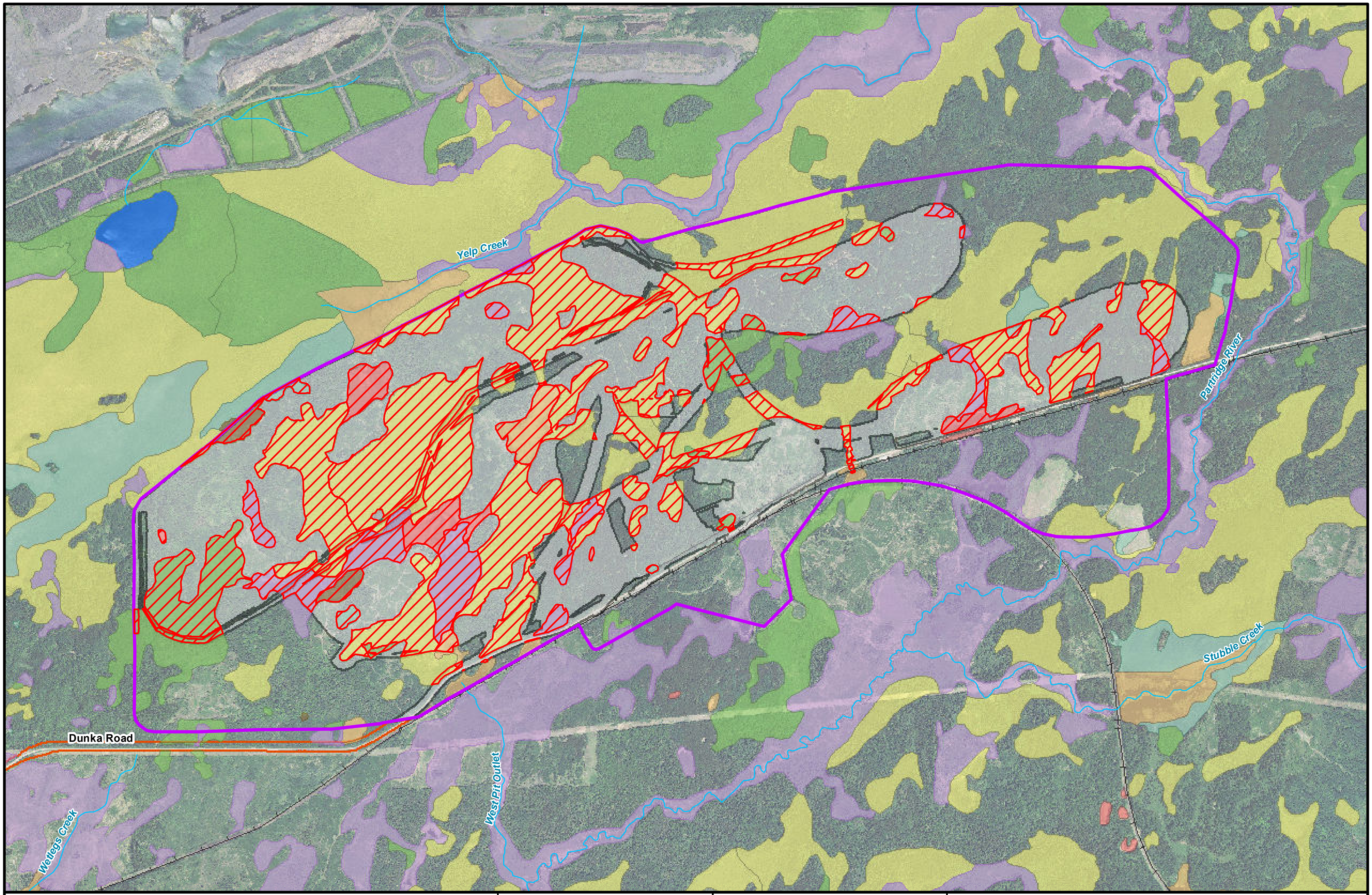

Mine Site
Transportation and Utility Corridor
Directly Affected Wetland
Proposed Disturbed Area
Stream/River

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Hardwood Swamp
Deep Marsh & Shallow Marsh
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

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0 500 1,000 2,000 3,000 Feet

Figure 5.2.3-1

Mine Site Wetlands and Direct Wetland Effects

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Table 5.2.3-2 Type of Projected Direct Wetland Effects at the Mine Site and the Transportation and Utility Corridor

	Directly Affected Wetlands at Mine Site			Directly Affected Wetlands at Transportation and Utility Corridor		
Type of Effect	**Acres**	**%**	**No.**	**Acres**	**%**	**No.**
Fill	77.3	10	14	7.2	100	25
Excavation	87.9	12	23	0.0	0	0
Fill and Excavation	593.0	78	22	0.0	0	0
Total Direct Effects	758.2	100	59	7.2	100	25

Source: PolyMet 2013b.

PolyMet proposes to avoid and minimize wetland effects 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 saturated overburden and temporary stockpiles, and leave only unsaturated overburden and peat in the Overburden Storage and Laydown Area. By doing so, the footprint of these stockpiles would be reduced, resulting in fewer direct wetland effects.

In approximately year 40, flooding to the West Pit would be complete. Discharge from the West Pit would be pumped to the WWTF for treatment. The WWTF would then be upgraded to include reverse osmosis treatment to achieve a 10 mg/L sulfate effluent, which would then be discharged into a wetland and finally through a stream channel to the Partridge River. The direct effects on this wetland have been included within the wetland effect direct totals in Table 5.2.3-1.

Construction activities within the Transportation and Utility Corridor would affect 7.2 acres of wetlands, all of which would be filled. Table 5.2.3-1 summarizes the directly affected wetlands within the Transportation and Utility Corridor by community type while Table 5.2.3-2 identifies the activity that causes the effects expected within the Transportation and Utility Corridor. The wetland types that would be directly affected include shrub swamps (57 percent), coniferous swamps (22 percent), coniferous bogs (12 percent), and shallow marshes (8 percent) (see Figure 5.2.3-2). All of the wetlands to be directly affected are rated as high quality. 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.

5.2.3.2.2 Mine Site and Transportation and Utility Corridor Indirect Wetland Effects

The indirect wetland effects were assessed by identifying wetlands in Area 1 within 500-foot increments beginning at the edge of the mine pits and extending to a maximum distance of 10,000 feet (see Figure 5.2.3-3) (PolyMet 2013b). The area of evaluation for the Mine Site indirect wetlands effects included only wetlands within Area 1 where wetland type information had been developed and does not include the directly affected wetlands.

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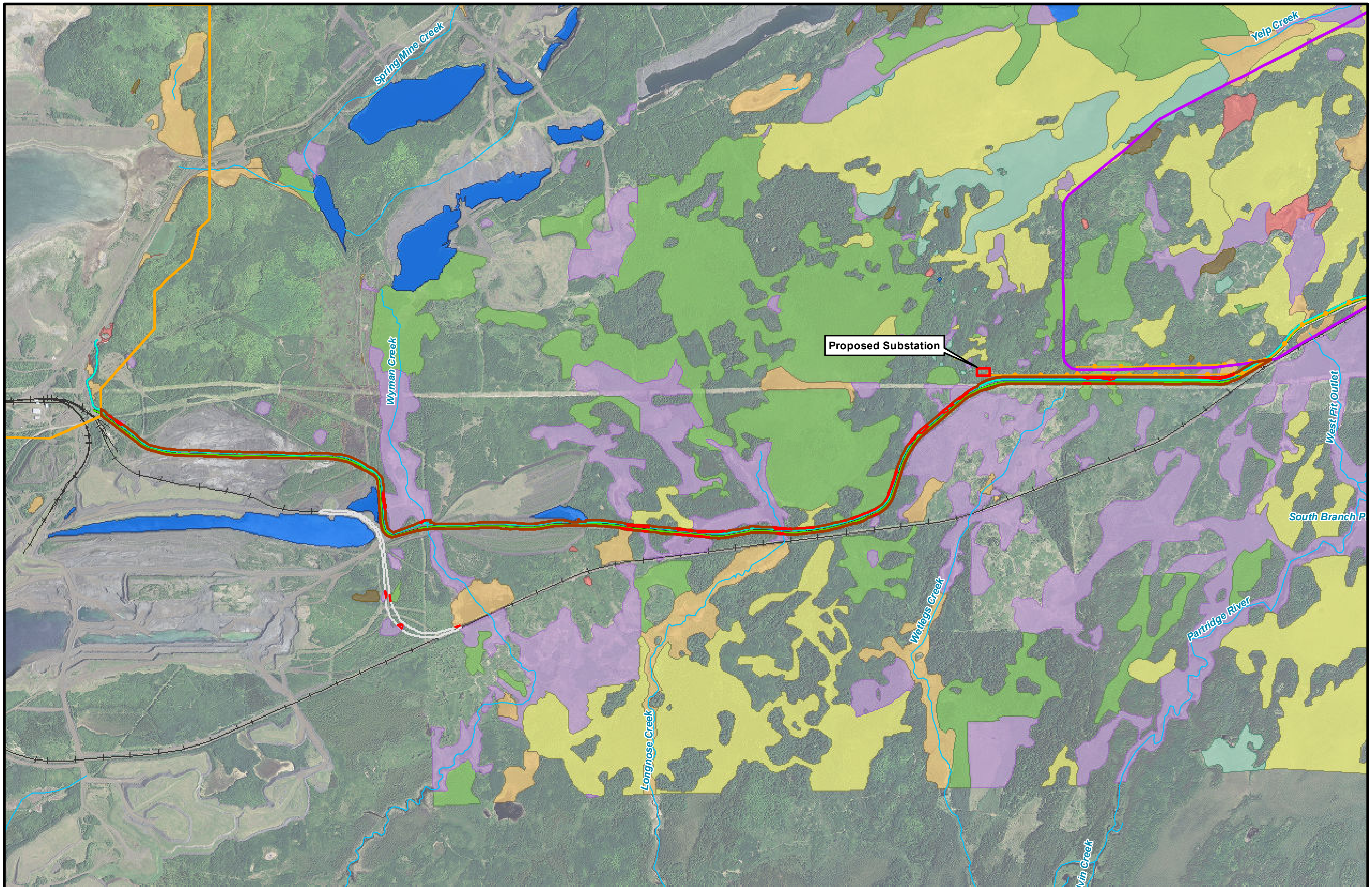

Transportation and Utility Corridor
Directly Affected Wetland
Proposed Transmission Line
Treated Water Pipeline
Dunka Road
Railroad Connection
Mine Site
Plant Site
Existing Railroad
Stream/River

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Deep Marsh & Shallow Marsh
Hardwood Swamp
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

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N E S W

0 1,000 2,000 4,000 Feet

Figure 5.2.3-2

Transportation and Utility Corridor Wetlands and Direct Wetland Efects

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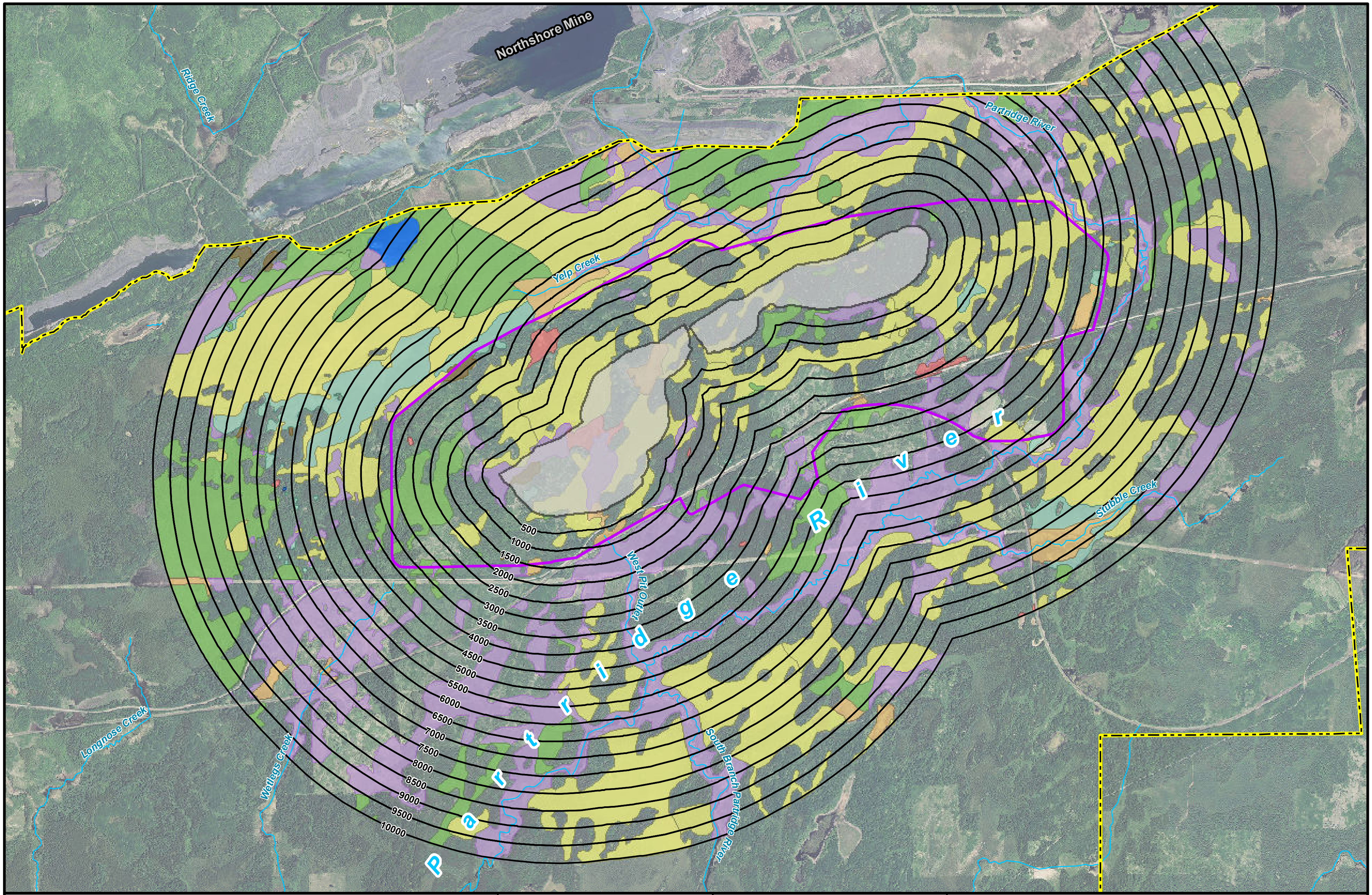

Mine Site
500 ft Increments
Area 1
Mine Pit
Stream/River
Eggers & Reed Wetland Types
Coniferous Bog
Coniferous Swamp
Open bog
Deep Marsh & Shallow Marsh
Hardwood Swamp
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

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N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-3
Wetlands within 500 ft Increments at the Mine Site
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Wetland Fragmentation

Construction of the Mine Site features (e.g., open pits, stockpiles, haul roads, etc.) would result in approximately 26.4 acres of wetland fragments (see Figure 5.2.3-4). Wetlands were determined to be fragmented and their associated remaining acreage included as a potential indirect wetland effect if they were small remnants of a directly affected wetland located between Mine Site features (e.g., in the area between the Category 1 Stockpile and the West Pit or along Dunka Road or the Railroad Connection Corridor). The majority of the wetland fragments in the Mine Site would consist of coniferous bog (79 percent), shrub swamps (14 percent), coniferous swamp (7 percent), and sedge/wet meadow (less than 1 percent). In addition, a 0.01 acre shrub swamp would become fragmented just outside of the Transportation and Utility Corridor near Dunka Road but within Area 1 (PolyMet 2013b). No wetlands would become fragmented along the Railroad Corridor.

Changes in Hydrology Due to Change in Watershed Area

The potential for indirect effects to wetland acreage not directly affected due to change in watershed area were assessed by evaluating the change in watershed area per acre of wetland (PolyMet 2013b). Watersheds were defined for each wetland within the Mine Site boundary, as well as wetlands outside the Mine Site with a watershed area that may be affected by NorthMet Project area features. Wetland and watershed areas were determined for the following conditions: existing conditions, during operations when the maximum amount of watershed has been removed (i.e., maximum NorthMet Project Proposed Action extent), and at long-term closure.

The analysis was completed by first defining the watershed area (i.e., the sum of upland area and wetland area). For each wetland in the Mine Site, GIS was used to determine the upland area (acres) and wetland area (acres) within each watershed area (acres). Using these acreages, the percentage of a wetland within its watershed was calculated (PolyMet 2011m).

The existing conditions include wetlands that represent the existing and relatively undisturbed conditions at the Mine Site. The analysis included wetlands and associated watersheds that are partially or completely within the Mine Site boundary. There are a total of 3,325 acres of wetlands within 6,287 acres of watershed, which results in approximately 53 percent of the analysis area covered by wetlands (PolyMet 2013b).

During operations, some wetlands and watershed areas may be directly affected by the NorthMet Project Proposed Action and would no longer be considered as a tributary area to the wetland. Consequently, the amount of water potentially contributed by the watershed to support the hydrology of the remaining wetlands may also change.

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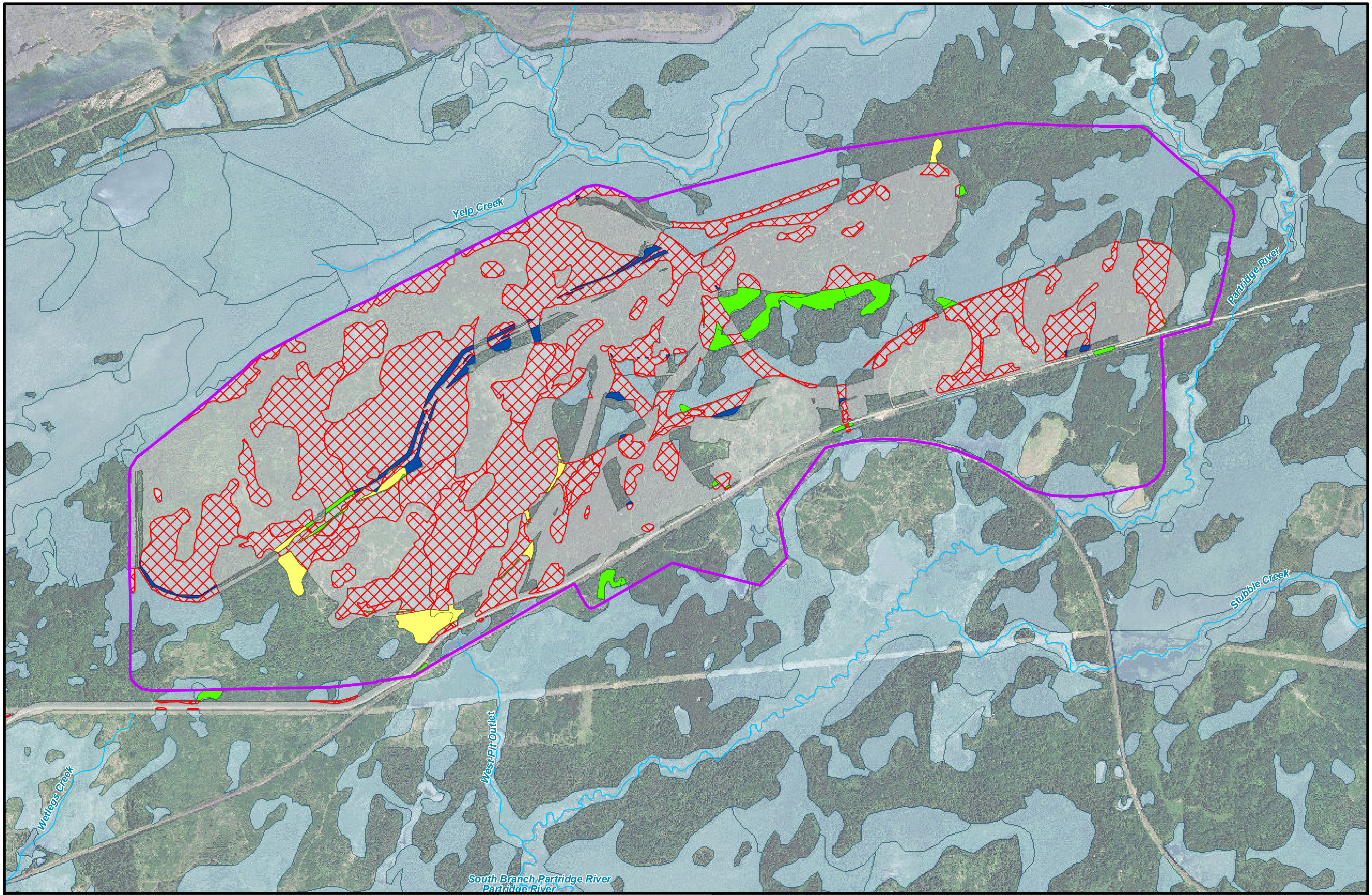

Mine Site
Disturbed Area
Directly Affected Wetland
Fragmented Wetlands
Wetlands

Potential Indirect Wetland Effects

Decrease in Yield per Wetland Acre of Greater Than 20%

Increase in Yield per Wetland Acre of Greater Than 20%

Stream/River

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0 500 1,000 2,000 3,000 Feet

Figure 5.2.3-4

Wetlands Potentially Indirectly Affected by Change in Watershed Area

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There would be 20 wetlands, indirectly affected, displaying an increase or decrease of greater than 20 percent equivalent yield. Ombrotrophic coniferous bogs and open bogs were not included in the total wetland acreage because their hydrology is supported by precipitation and is not dependent on the size of the watershed. There would be 35 acres (11 wetlands) that would have the potential to experience an increase in yield per wetland acre of greater than 20 percent, and 15 acres (9 wetlands) that would likely experience a decrease in yield per wetland acre in excess of 20 percent (see Figure 5.2.3-4). The 49.4 acres of potentially indirectly affected wetland types include shrub swamps (52 percent), coniferous swamp (34 percent), minerotrophic coniferous bog (8 percent), shallow marsh (6 percent), and sedge/wet meadow (less than 1 percent) (PolyMet 2013b).

During reclamation, a portion of the wetlands and wetland watersheds within the Mine Site would be restored to the existing condition.

Changes in Hydrology Due to Drawdown

The geologic and hydrogeologic settings of the Mine Site and the analog sites are fairly similar with a thin veneer of heterogeneous unconsolidated deposits underlain by fractured bedrock. The hydraulic conductivities of the unconsolidated deposits and bedrock are lower at the Mine Site than at the analog sites, and so it is expected that the wetland impact zones would likely overestimate the extent of potential wetland effects. Because of the thin, discontinuous nature of the surficial deposits at the Mine Site, drawdown effects are expected to be more localized at the Mine Site than at the analog sites. Additionally, the numerous bedrock outcrops present at the Mine Site are expected to act as barriers to flow in the unconsolidated aquifer, thereby limiting the area of influence of the mine pits. Whereas, the analog sites have fewer or no bedrock outcrops compared to the Mine Site. Last, the presence of the Partridge River approximately 4,000 to 6,000 feet south (downstream) of the mine pits is likely to act as a natural barrier to the expansion of the cone of depression within the surficial aquifer (PolyMet 2013b).

Bog wetlands within and surrounding the Mine Site were reclassified as either ombrotrophic (hydrology and mineral inputs entirely from direct precipitation) or minerotrophic (some degree of mineral inputs from groundwater and/or surface water runoff) to determine if the bogs would be affected by groundwater drawdown. Ombrotrophic bogs would likely not be affected by groundwater drawdowns associated with proposed mining operations, whereas more minerotrophic bogs would have a higher likelihood of being affected.

The potential indirect wetland effect from glacial aquifer drawdown was based on the analog impact zone with the greater potential drawdown (zone closer to the open pit mine) for wetlands that lie on both sides of the analog distance boundary. Wetlands were identified within four analog impact zones from the edge of the mine pits within Area 1 (see Figure 5.2.3-5). Wetlands that were located within multiple analog impact zones were included in the analog impact zone closest to the edge of the mine pits (see Figures 5.2.3-6 through 5.2.3-10). Based on this analysis, there would be 1,390.3 acres of wetlands in the 0-1,000 feet zone, 618.6 acres in the >1,000-2,000 feet zone, 1,194.2 acres of wetlands in the >2,000-3,500 feet zone, and 3,866.5 acres of wetlands in the >3,500-10,000 feet zone beyond the edge of the pits (see Table 5.2.3-3).

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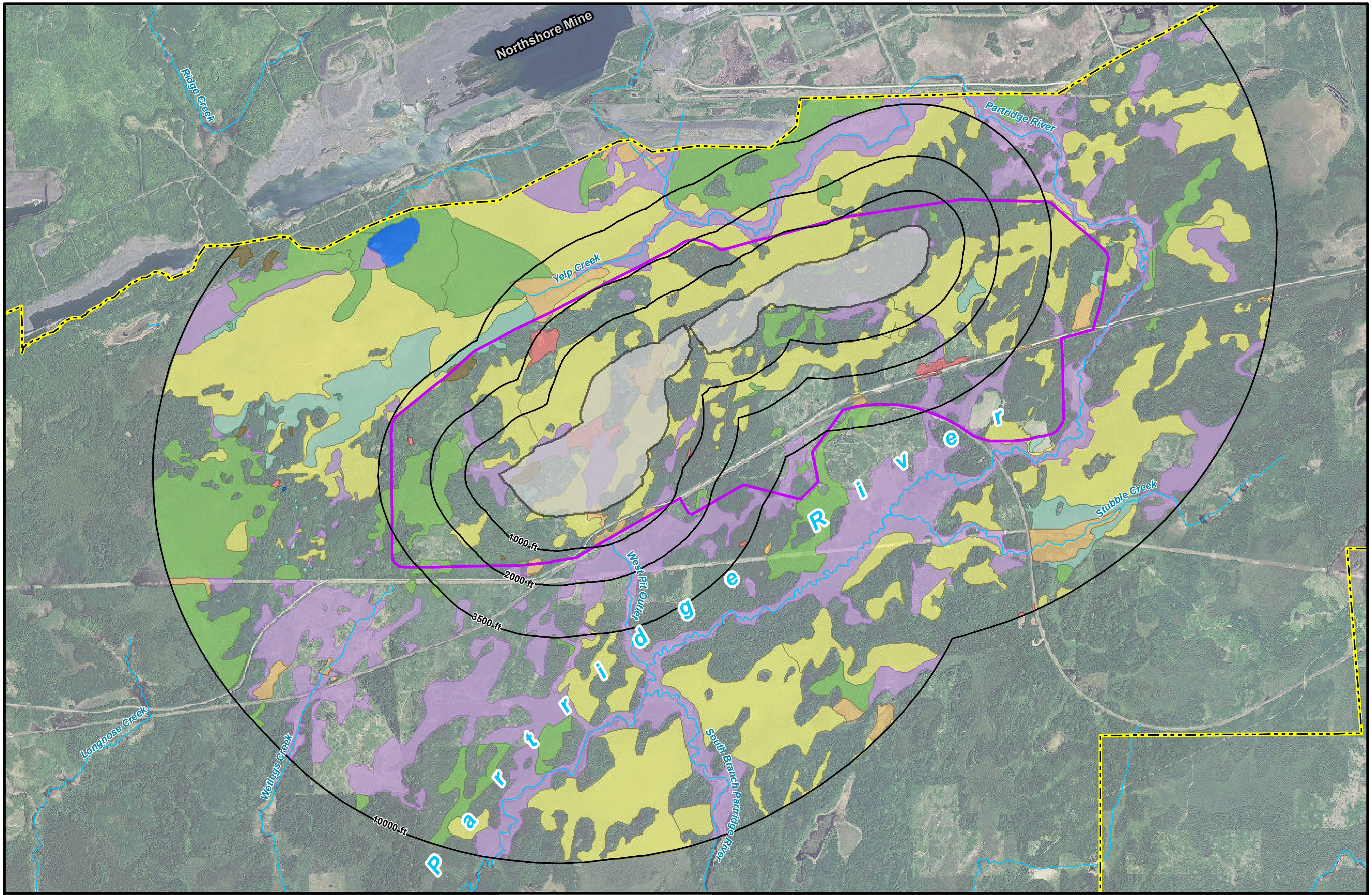

Mine Site
Analog Zones (feet)
Area 1
Mine Pit
Stream/River

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Open bog
Deep Marsh & Shallow Marsh
Hardwood Swamp
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

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N
W E
S

0 0.25 0.5 1 Miles

Figure 5.2.3-5
Wetlands within Analog Zones at the Mine Site
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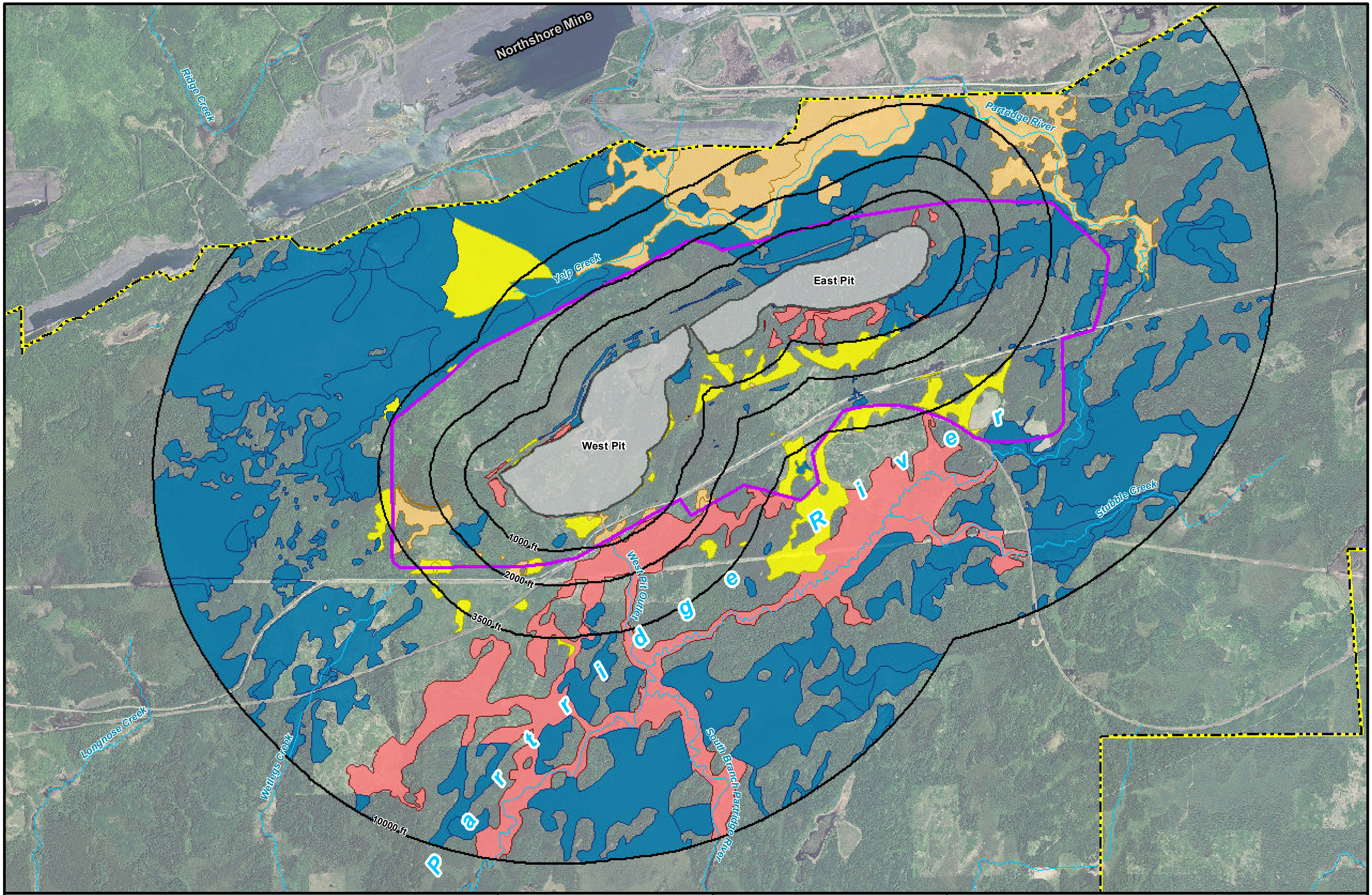

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect

High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

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0 0.25 0.5 1 Miles

Figure 5.2.3-6
Wetlands Crossing Analog Zones - 0-10,000 feet of Edge of Mine Pits
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Minnesota

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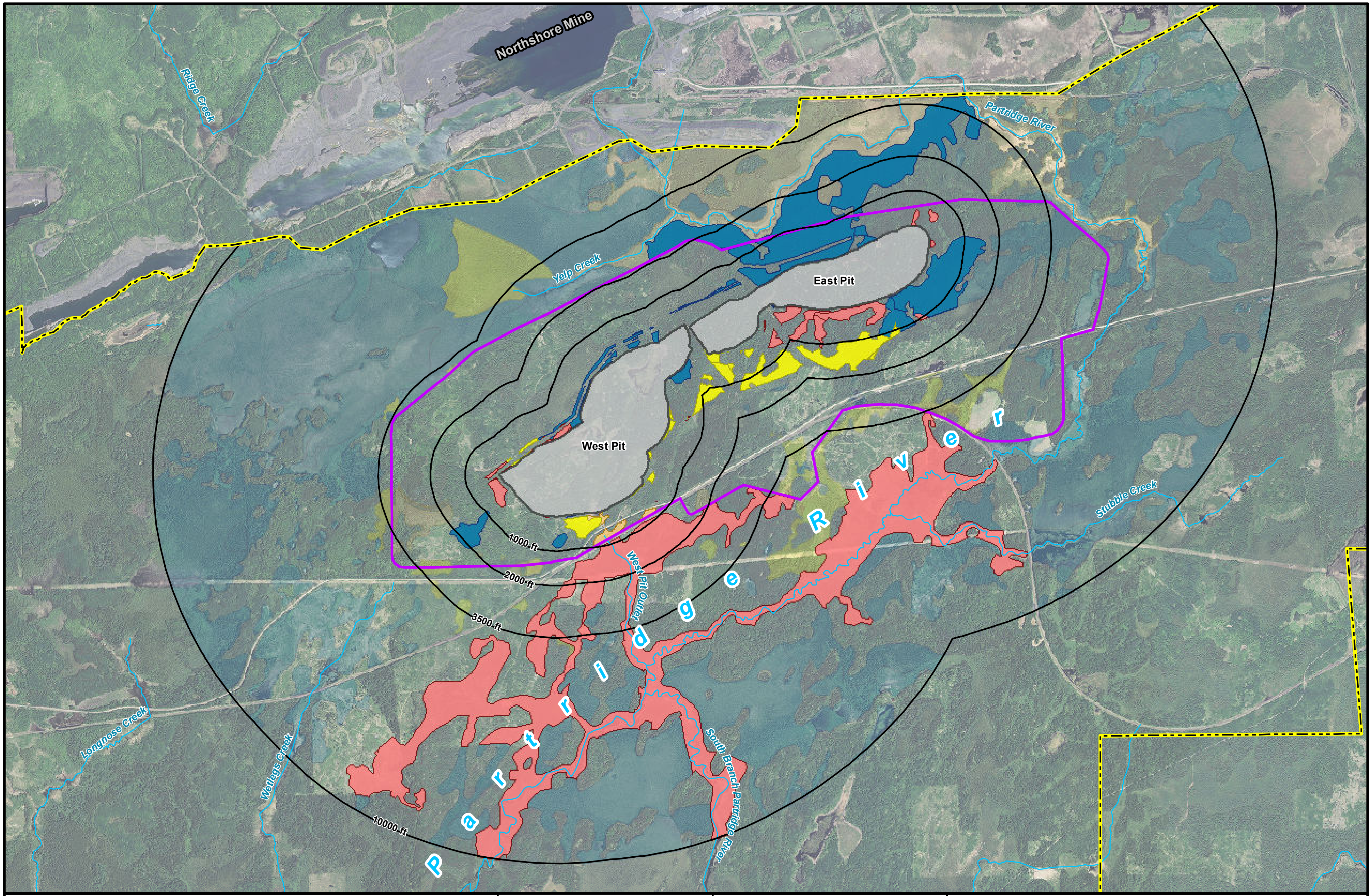

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

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0 0.25 0.5 1 Miles

Figure 5.2.3-7
Wetlands Crossing Analog Zones - 0-1,000 feet of Edge of Mine Pits
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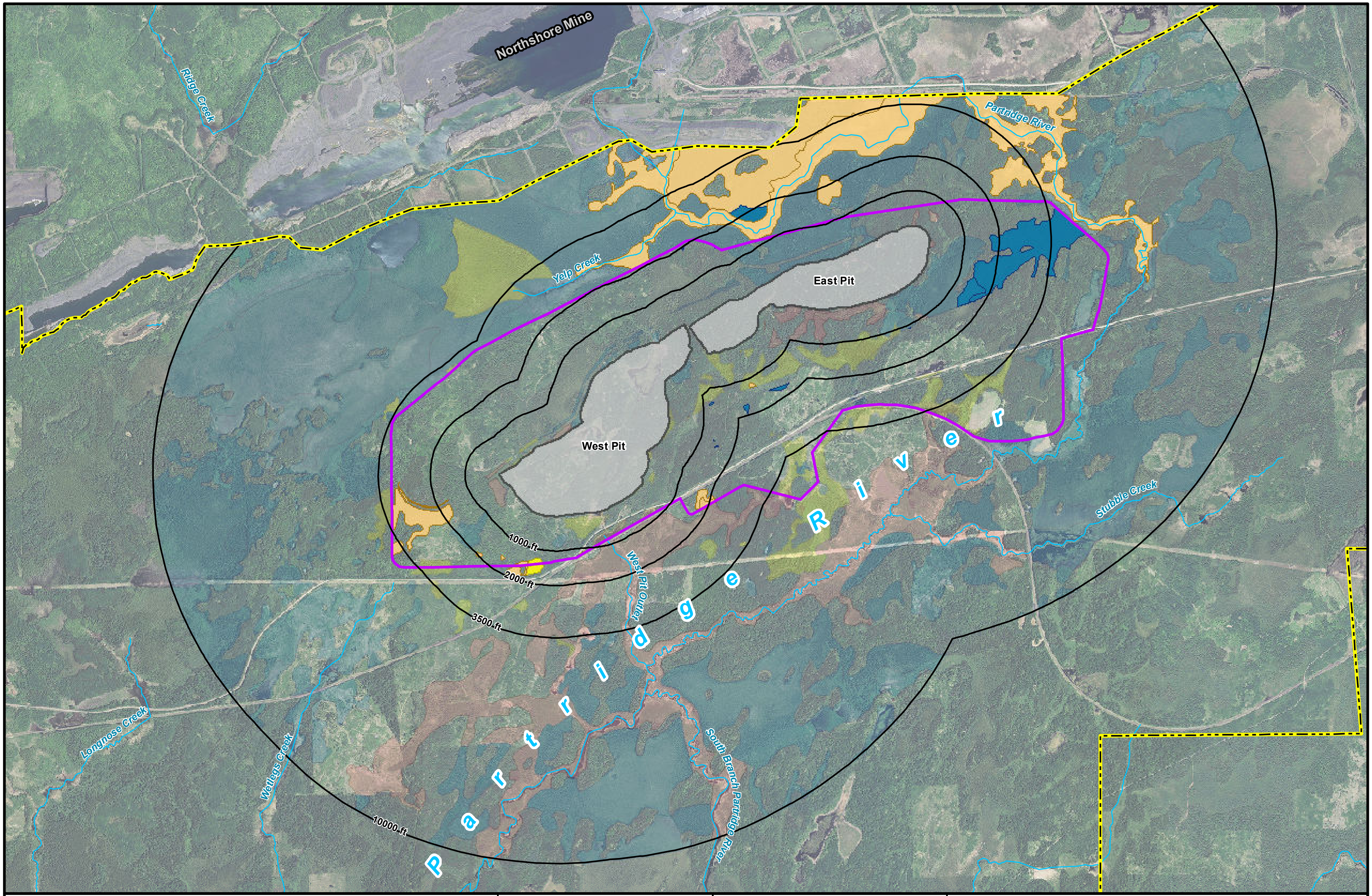

- Mine Site
- Mine Pit
- Analog Zones (feet)
- Area 1
- Stream/River

Likelihood of Wetland Hydrology Effect

- High Likelihood
- Moderate Likelihood
- Low Likelihood
- No Effect

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0 0.25 0.5 1 Miles

Figure 5.2.3-8

Wetlands Crossing Analog Zones - >1,000-2,000 feet of Edge of Mine Pits

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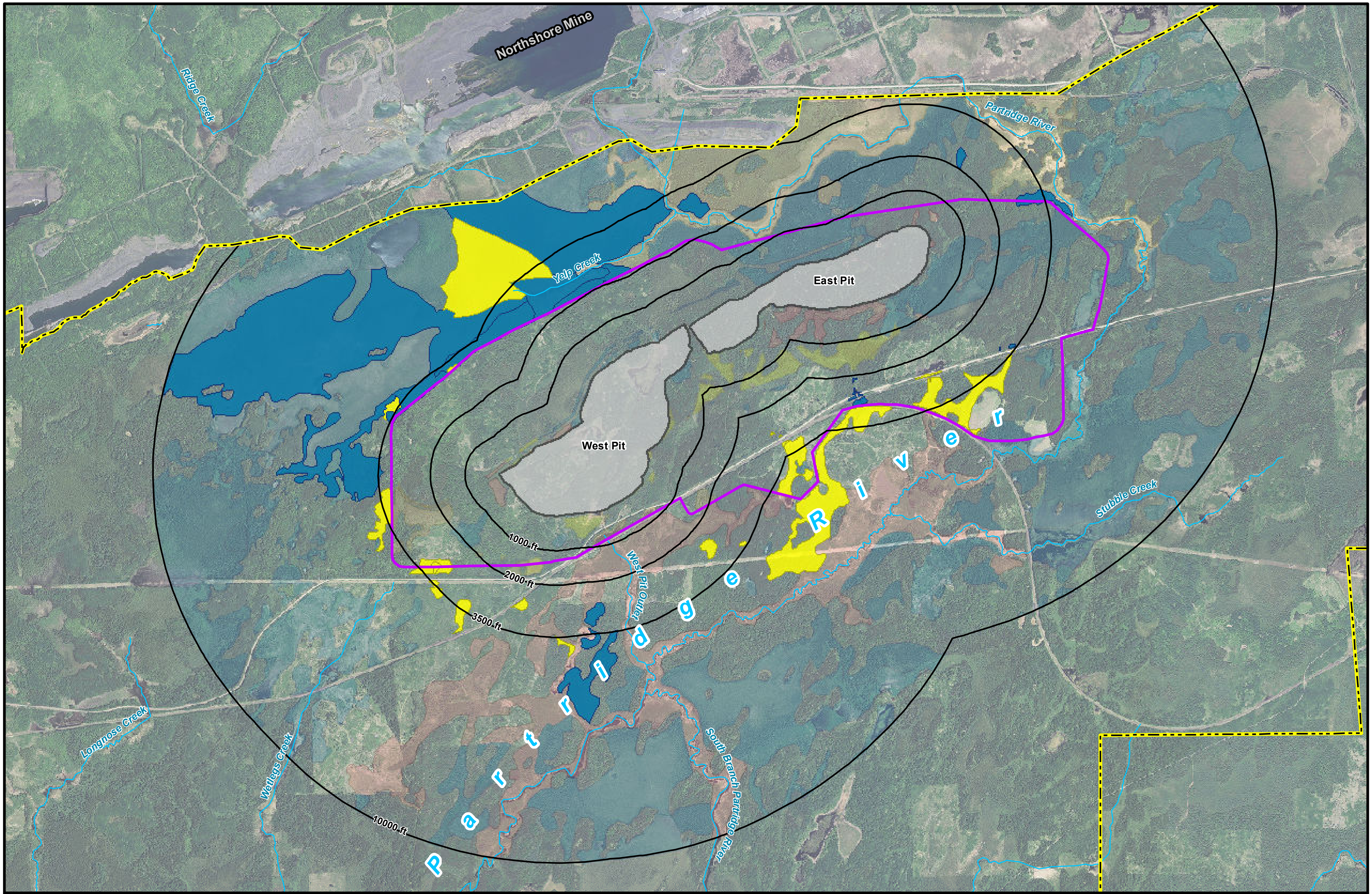

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

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0 0.25 0.5 1 Miles

Figure 5.2.3-9
Wetlands Crossing Analog Zones - >2,000-3,500 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange PSDEIS
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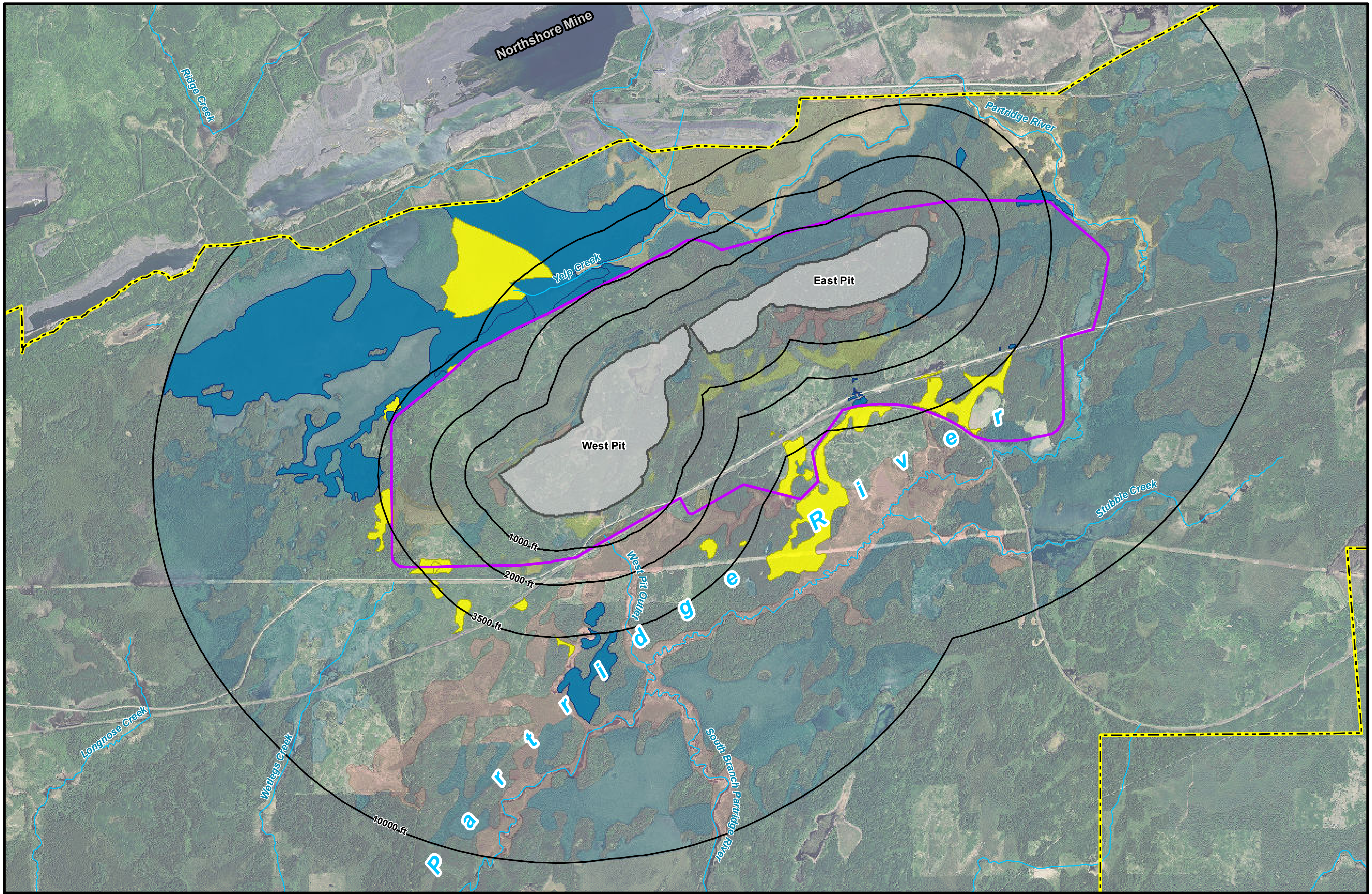

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect

High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-10
Wetlands Crossing Analog Zones - >3,500-10,000 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange PSDEIS
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Table 5.2.3-3 Wetlands Crossing Analog Impact Zones Resulting from Changes in Hydrology

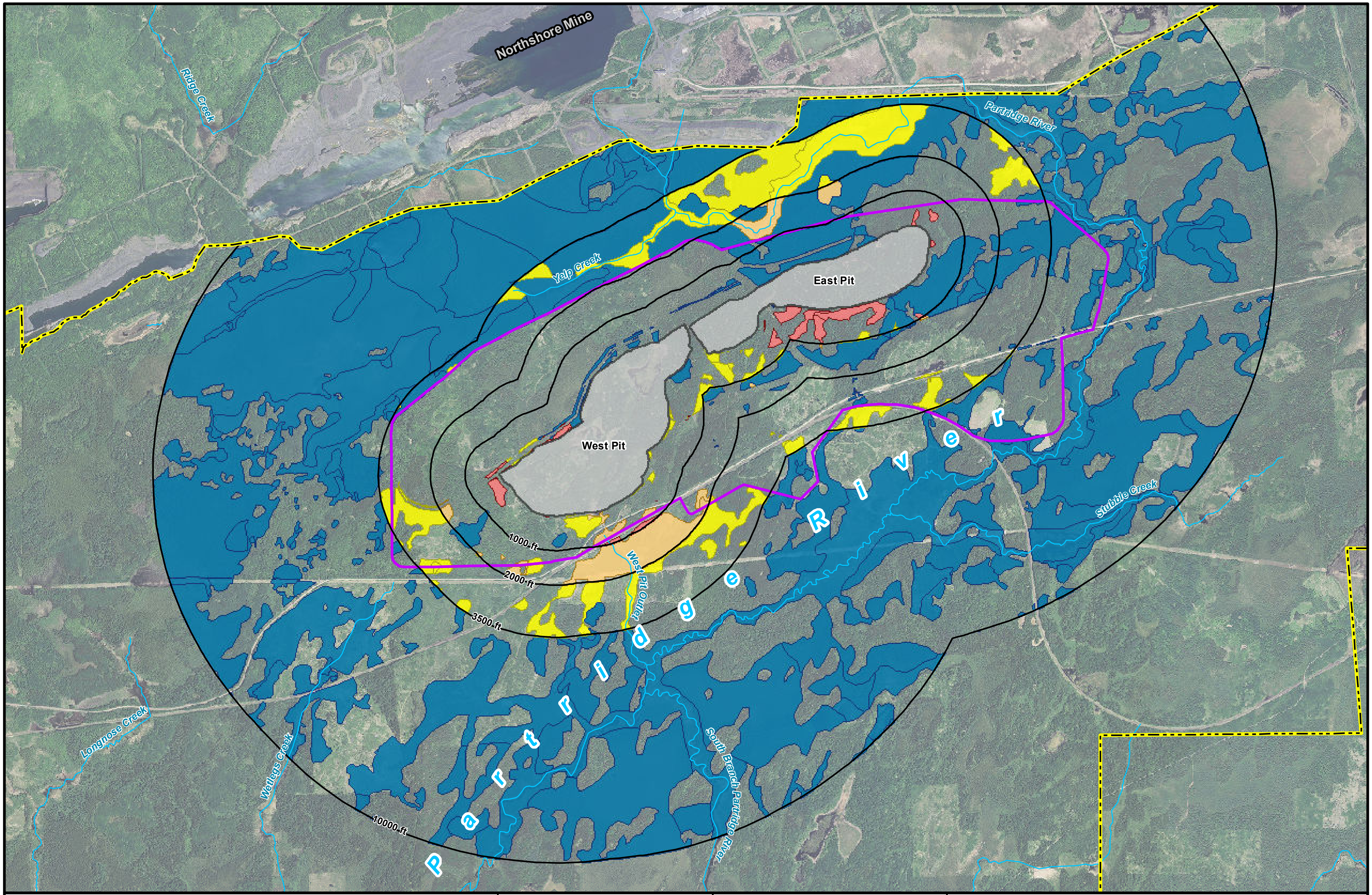
Likelihood of Wetland Hydrology Effect Based on Wetland Type for Each Analog Distance	Wetland Area (acres) within each Analog Increement 0-1,000 feet	1,000-2,000 feet	2,000-3,500 feet	3,500-10,000 feet	Eggers and Reed Wetland Community
0 – 1,000 feet					
High Likelihood	929.2	-	-	-	Coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Moderate Likelihood	9.3	-	-	-	Deep marsh, shallow marsh, and shallow, open water
Low Likelihood	76.7	-	-	-	Minerotrophic coniferous bog
No Effect	376.1	-	-	-	Ombrotrophic coniferous bog and open bog
1,000 – 2,000 feet					
Moderate Likelihood	-	522.4	-	-	Coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Low Likelihood	-	4.1	-	-	Deep marsh, shallow marsh, and shallow, open water
No Effect	-	92.1	-	-	Minerotrophic and ombrotrophic coniferous bog and open bog
2,000 – 3,500 feet					
Low Likelihood	-	-	293.1	-	Coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
No Effect	-	-	901.0	-	Deep marsh, shallow marsh, and shallow, open water, minerotrophic and ombrotrophic coniferous bog and open bog
3,500 – 10,000 feet					
No Effect	-	-	-	3,866.5	All wetland types
Total Acres of Wetland	**1,390.3**	**618.6**	**1,194.2**	**3,866.5**	

Source: PolyMet 2013b.

There would be a total of 7,069.6 acres of wetlands within these four analog impact zones (see Table 5.2.3-3). The likelihood of wetland hydrology effects would be as follows: no effect on 5,235.7 acres of wetlands (74 percent); low likelihood to 373.9 acres of wetlands (5 percent); moderate likelihood to 531.7 acres of wetlands (8 percent); and high likelihood to 929.2 acres of wetlands (13 percent) (see Table 5.2.3-3). Within 0-10,000 feet from the edge of the mine pits, wetland types with a high likelihood of wetland hydrology effects include shrub swamps (910 acres), coniferous swamp (19 acres), and sedge/wet meadow (less than 1 acre); with a moderate likelihood include shrub swamp (327 acres), coniferous swamp (195 acres), deep marsh (5 acres), shallow marsh (3 acres), and hardwood swamp (less than 1 acre); and with a low likelihood include coniferous swamp (223 acres), coniferous bog (77 acres), shrub swamps (68 acres), shallow marsh (4 acres), sedge/wet meadow (2 acres), and hardwood swamp (less than 1 acre) (PolyMet 2013b).

The wetlands categorized as high likelihood are dominated by one alder thicket (886 acres) that has approximately 4 acres (less than 1 percent) within the 0-1,000 feet analog impact zone. The remainder of this wetland (more than 99 percent) is located more than 1,000 feet away from the edge of the mine pits and extends out to the edge of Area 1 (see Figure 5.2.3-6).

Based on the analog data, hydrologic effects to peat wetlands would only be observed to occur within 1,000 ft from the edge of the mine pits. Therefore, wetlands were categorized within the analog impact zones using an alternate method to determine the likelihood of wetland hydrology effects. For this method, wetlands that were located within multiple analog impact zones were split along zone edges, and acreages were calculated by zone. As a result, the acreage for wetlands crossing zone edges was split among multiple zones, rather than included in the analog impact zone that was closest to the edge of the mine pits, as done above. The acreage of each wetland type located within these impact zones is summarized in Table 5.2.3-4 and locations are shown in Figures 5.2.3-11 through 5.2.3-15. Using this analysis approach, there would be 233.5 acres of wetlands in the 0-1,000 feet zone, 311.0 acres in the >1,000-2,000 feet zone, 718.0 acres of wetlands in the >2,000-3,500 feet zone, and 4,564.4 acres of wetlands in the >3,500-10,000 feet zone (PolyMet 2013b).



Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St. Paul District

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N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-11
Wetlands Within Analog Zones - 0-10,000 feet of Edge of Mine Pits
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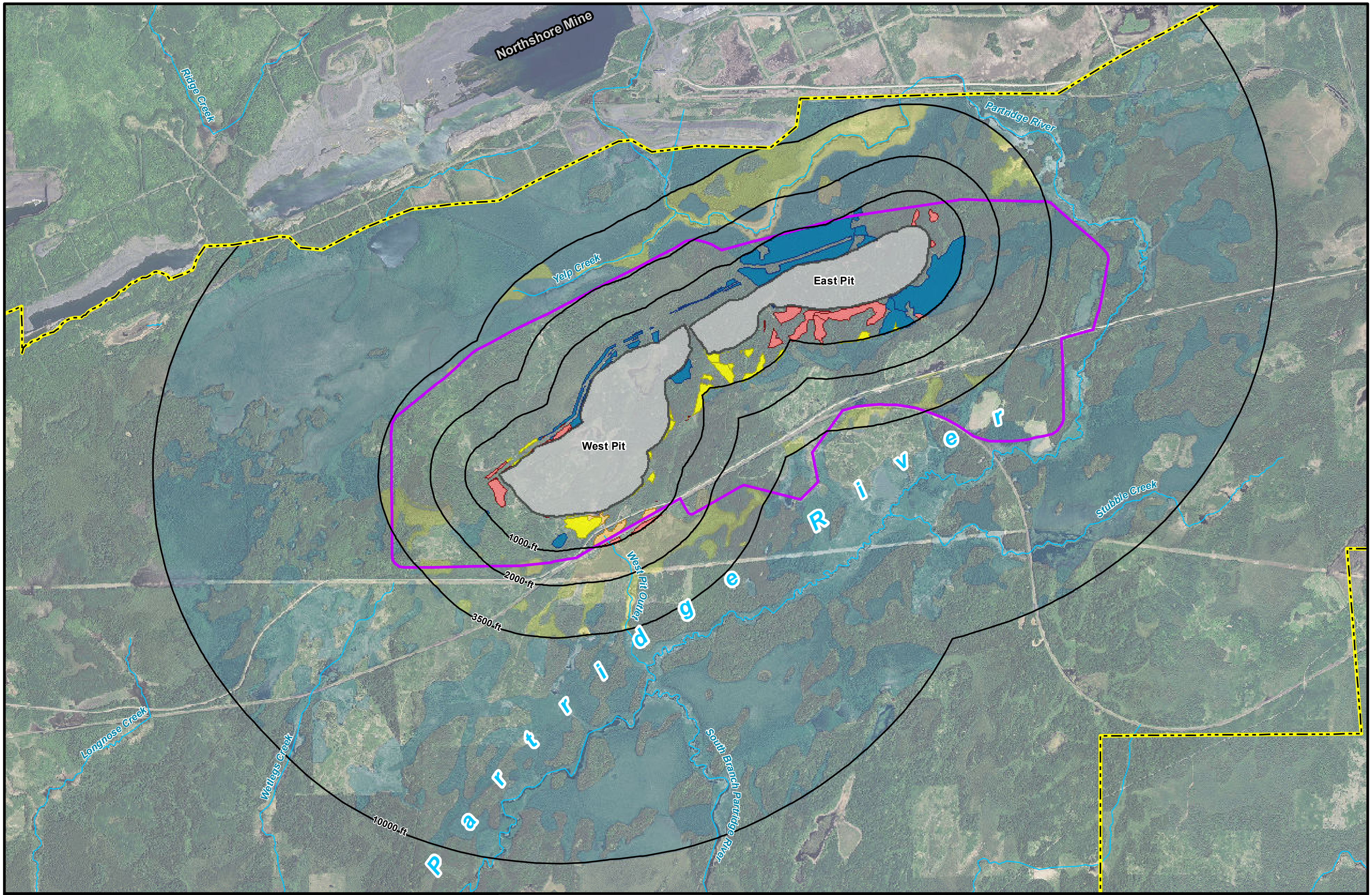

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect

High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

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0 0.25 0.5 1 Miles

Figure 5.2.3-12
Wetlands Within Analog Zones -
0-1,000 feet of Edge of Mine Pits
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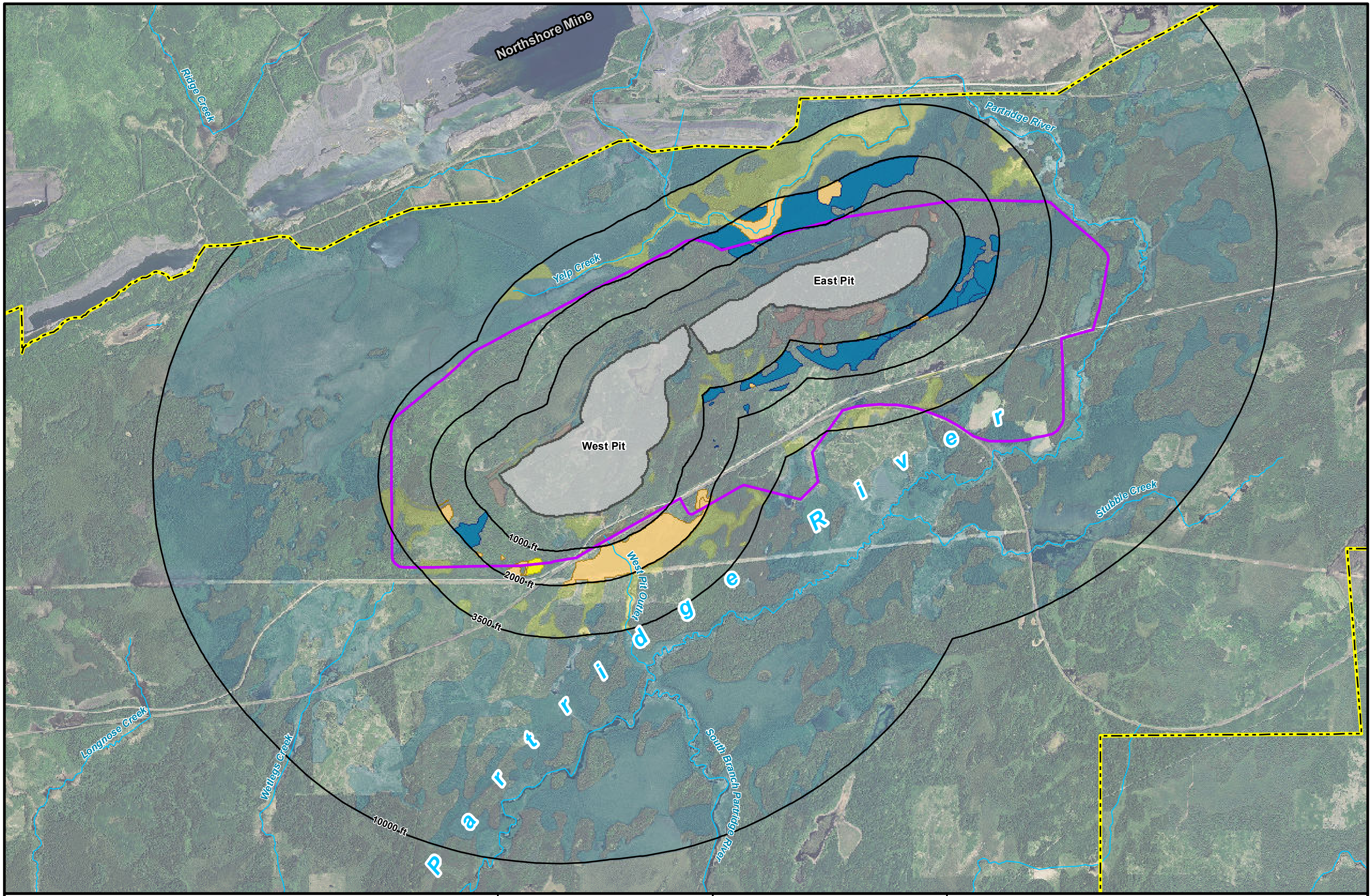

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-13
Wetlands Within Analog Zones - >1,000-2,000 feet of Edge of Mine Pits
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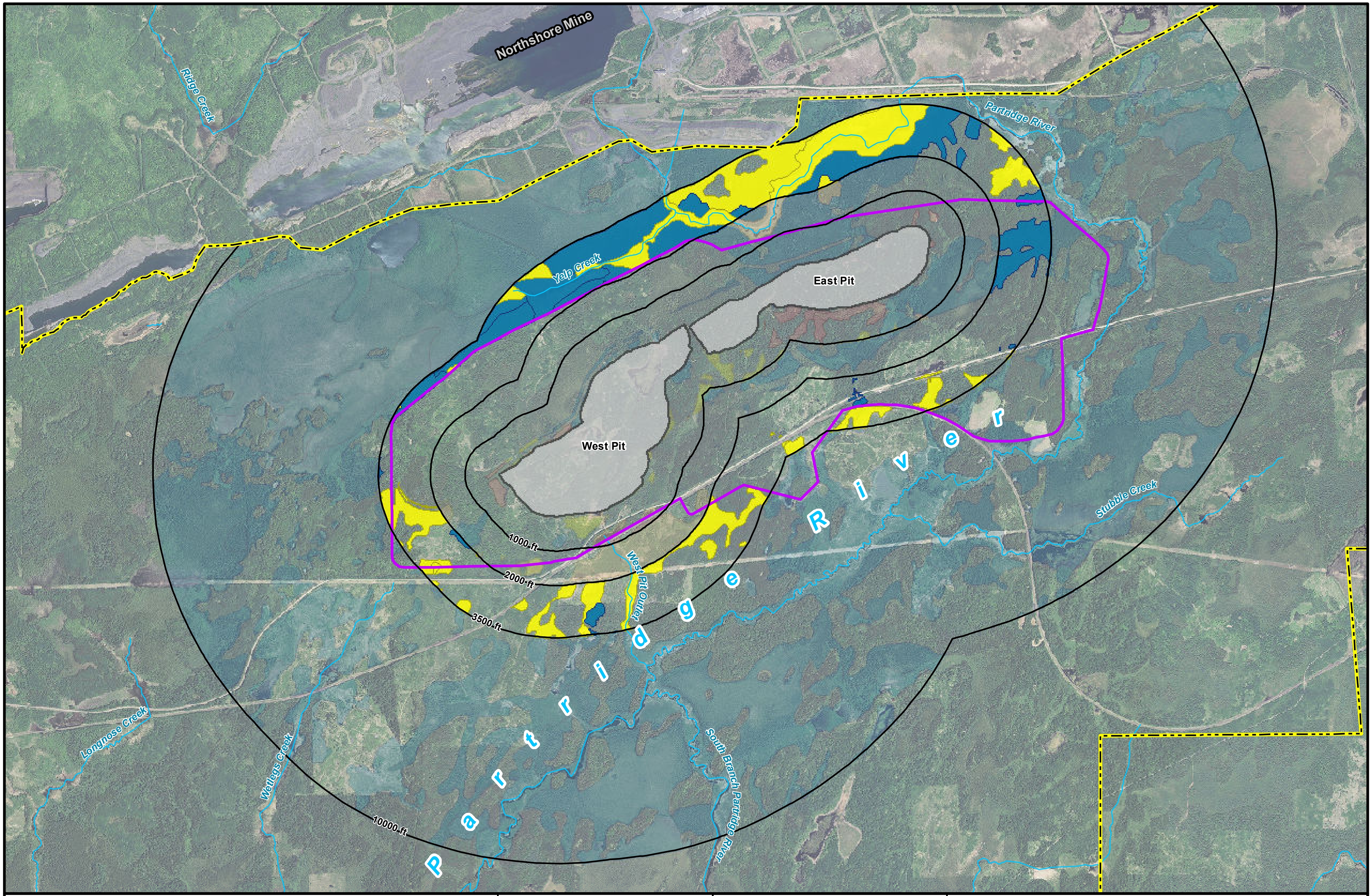

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect

High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St. Paul District

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Figure 5.2.3-14
Wetlands Within Analog Zones - >2,000-3,500 feet of Edge of Mine Pits
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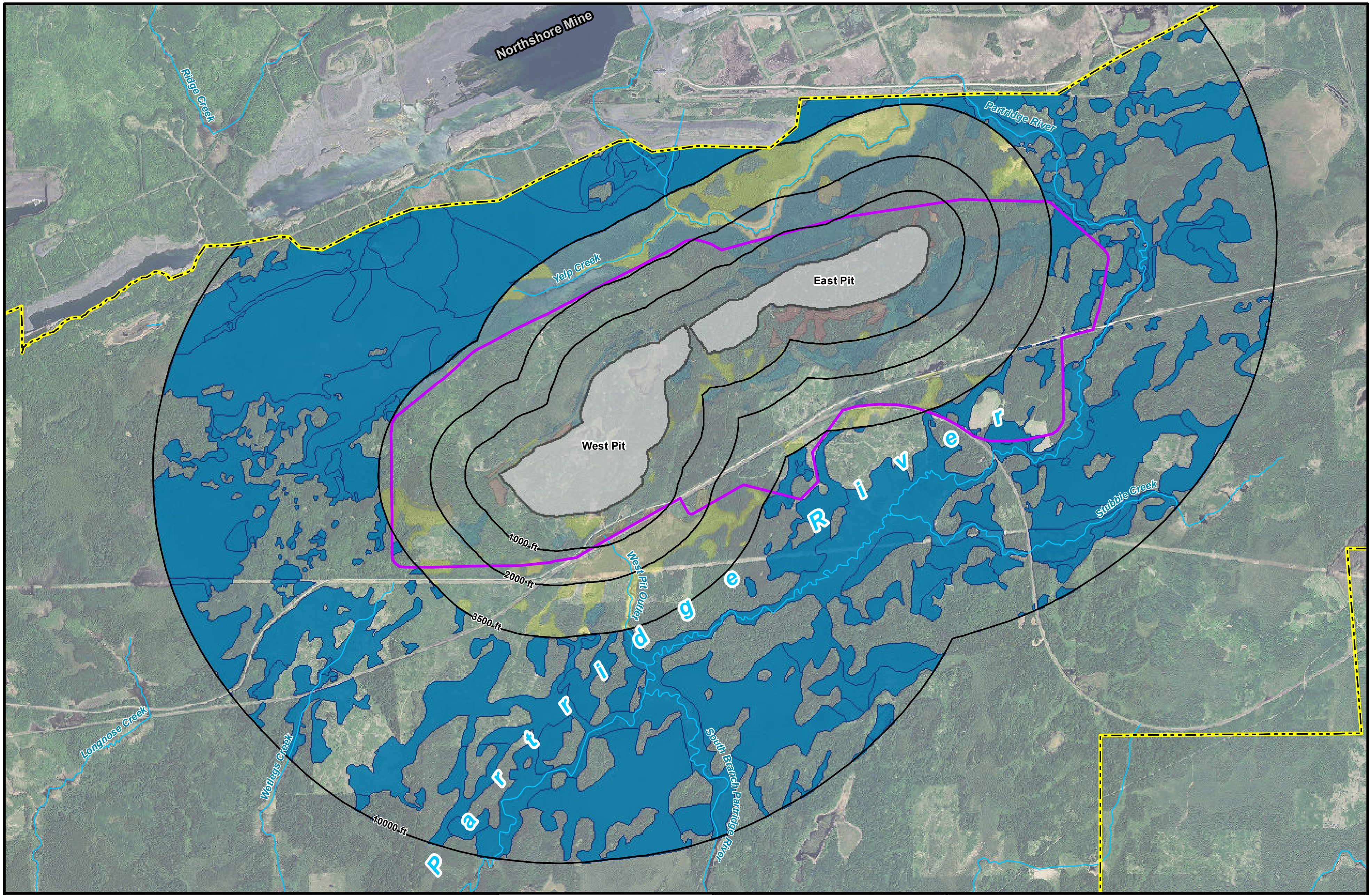

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect

High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St. Paul District

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N S E W

0 0.25 0.5 1 Miles

Figure 5.2.3-15

Wetlands Within Analog Zones - >3,500-10,000 feet of Edge of Mine Pits

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Table 5.2.3-4 Wetlands Within Analog Impact Zones Resulting from Changes in Hydrology

Likelihood of Wetland Hydrology Effect Based on Wetland Type for Each Analog Distance	Wetland Area (acres) within each Analog Increment				
	0-1,000 feet	**1,000-2,000 feet**	**2,000-3,500 feet**	**3,500-10,000 feet**	**Eggers and Reed Wetland Community**
0 – 1,000 feet					
High Likelihood	46.4	-	-	-	coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Moderate Likelihood	8.3	-	-	-	deep marsh, shallow marsh, and shallow, open water
Low Likelihood	32.5	-	-	-	minerotrophic coniferous bog
No Effect	146.3	-	-	-	ombrotrophic coniferous bog and open bog
1,000 – 2,000 feet					
Moderate Likelihood	-	110.8	-	-	coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Low Likelihood	-	4.1	-	-	deep marsh, shallow marsh, and shallow, open water
No Effect	-	196.1	-	-	minerotrophic and ombrotrophic coniferous bog and open bog
2,000 – 3,500 feet					
Low Likelihood	-	-	385.0	-	coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
No Effect	-	-	333.0	-	deep marsh, shallow marsh, and shallow, open water, minerotrophic and ombrotrophic coniferous bog and open bog
3,500 – 10,000 feet					
No Effect	-	-	-	4,564.4	all wetland types
Total Acres of Wetland	**233.5**	**311.0**	**718.0**	**4,564.4**	

Source: PolyMet 2013b.

There would be a total of approximately 5,826.9 acres of wetlands within these four analog impact zones based on this approach (see Table 5.2.3-4). The likelihood of wetland hydrology effects would be as follows: no effect on 5,239.8 acres of wetlands (90 percent); low likelihood to 421.6 acres of wetlands (7 percent); moderate likelihood to 119.1 acres of wetlands (2 percent); and high likelihood to 46.4 acres of wetlands (1 percent) (see Table 5.2.3-4). Within 0-10,000 feet from the edge of the mine pits, wetland types with a high likelihood of wetland hydrology effects include shrub swamps (27 acres), coniferous swamp (19 acres), and sedge/wet meadows (less than 1 acre); those with a moderate likelihood include shrub swamp (96 acres), coniferous swamp (14 acres), deep marsh (5 acres), shallow marsh (3 acres), and hardwood swamp (less than 1 acre); and those with low likelihood include shrub swamp (247 acres), coniferous swamp (135 acres), coniferous bog (33 acres), shallow marsh (4 acres), sedge/wet meadow (2 acres), and hardwood swamp (1 acre) (PolyMet 2013b).

The potential indirect wetland hydrology drawdown effects on each wetland type were assessed based on the wetland sensitivity class tables for falling groundwater tables found in the Crandon mine project document titled *Wetland Impact Assessment Technical Memorandum – Appendix B*. The following provides a general discussion regarding potential indirect wetland effects that could occur based on hypothetical hydrologic drawdown levels using the hydrologic wetland sensitivity method. The potential indirect wetland effects that could occur include: conversion to other wetland community types, a change in vegetation without a change in community type, conversion to uplands, or other effects.

Three categories of hydrologic wetland sensitivity, each with associated groundwater drawdown levels for each wetland community type, were created for the hypothetical hydrologic drawdown wetland sensitivity assessment (PolyMet 2013b).

- None-to-Slight: Water level changes in which effect on the community would be slight to none with the potential for slight changes in abundance of various species but no change in species present. Monitoring or mitigation not anticipated.
- Moderate: Water level changes that may have a moderate effect on the wetland community with the potential for the loss and addition of some species. Monitoring recommended with mitigation based on monitoring results.
- Severe: Water level changes expected to result in severe effects on the community with the potential for considerable loss of characteristic plant species and invasion by other species, conversion of wetland type or conversion to upland. Monitoring should be conducted and mitigation may be required. According to the hydrologic wetland sensitivity method, wetlands in which groundwater is not the principal source of water and in which mitigation of surface water is planned (e.g., streamflow augmentation) should be excluded from this category.

The hydrologic wetland sensitivity method estimated how wetland communities would respond to groundwater drawdown by assuming that they would change to drier native plant communities or variants of the original community. No data or research was utilized from actual wetlands responding to groundwater drawdown; therefore, this analysis and related data can only be used as an initial estimate of what changes could be expected should groundwater levels actually fall as a result of the NorthMet Project Proposed Action. Monitoring of hydrology and vegetation within potentially affected wetlands represents the best method for documenting actual community changes resulting from hydrology changes, understanding complex hydrologic conditions, and identifying potential future indirect effects related from mine features.

The preliminary information developed for the hydrologic wetland sensitivity method was utilized to estimate what type of wetland effects might occur at the Mine Site assuming various, theoretical groundwater drawdown levels. Table 5.2.3-5 provides a summary of the estimated wetland community changes using the groundwater drawdown thresholds for each wetland type based on the hydrologic wetland sensitivity method.

Table 5.2.3-5 Potential Wetland Community Changes Due to Drawdown

Impact Sensitivity Category	**None**		**Moderate**		**Severe**	
Community Type	**Water Level Drawdown (feet)**	**Potential Effect**	**Water Level Drawdown (feet)**	**Potential Effect**	**Water Level Drawdown (feet)**	**Potential Effect**
Ombrotrophic Coniferous and Open bog	<1	None	1-2	Minor changes in vegetation; Increased tree growth	>2	Possible conversion of wetland type
Minerotrophic Coniferous and Open bog	<0.5-1	None	0.5-2	Change in vegetation; Increased tree growth	>2	Possible conversion of wetland type
Shallow marsh[1]	<1	None	1-3	Conversion of type	>3	Conversion of wetland type
Deep marsh[1]	<2	None	2-4	Conversion of type	>4	Conversion of wetland type
Shallow, open water[1]	<2	None	2-4	Conversion of type	>4	Conversion of wetland type
Conifer swamp	<0.75-2	None	0.75-4	Minor changes in vegetation; Increased tree growth	>2-4	Change in vegetation
Hardwood swamp	<2	None	2-4	Change in vegetation; Increased tree growth	>4	Conversion of wetland type; possible conversion to upland
Alder thicket	<1	None	1-4	Change in vegetation; Increased shrub growth	>4	Conversion of wetland type; increased shrub growth
Shrub-carr	<0.5	None	0.5-3	Change in vegetation; Increased shrub growth	>3	Conversion of wetland type
Sedge/wet meadow	<0.5	None	0.5-3	Change in vegetation; Conversion of type	>3	Conversion to upland

Source: PolyMet 2013b.

[1] Shallow marsh, deep marsh, and shallow open water communities were not evaluated in the hydrologic wetland sensitivity method as described in the Wetland Work Plan, but were estimated based on best professional judgment (PolyMet 2013b).

For minor groundwater drawdown (ranging from 0.5 to 2 ft), no substantial wetland community changes were identified. For the moderate sensitivity category (water level changes ranging from 0.5 to 4 ft), some changes to vegetation would be possible in all wetland communities with marshes, open water, and meadows, potentially resulting in conversion of wetland type, and there could be increased shrub or tree growth in shrub or forested wetlands. For the severe sensitivity category, nearly all wetland community types would be estimated to convert to other wetland types with a few wetlands estimated to convert to upland, including meadow wetlands and possibly hardwood swamps (PolyMet 2013b). Monitoring to document effects to wetlands would be recommended for all potential effects in the moderate and severe categories.

Groundwater modeling cannot reasonably estimate potential indirect wetland effects; therefore, analog impact zones can provide a reasonable estimate of the extent of potential indirect wetland effects resulting from hydrologic effects. In addition, the evaluation of theoretical groundwater drawdown levels can help estimate what types of potential indirect wetland effects might occur. However, wetland hydrology is a complex mix of precipitation, surface runoff, and in some cases, groundwater. The response of complex natural systems to human disturbances can only be estimated. Therefore, monitoring of wetland hydrology and vegetation communities would occur to document the extent and magnitude of wetland responses (potential indirect effects) to human disturbances. The monitoring plan, developed as part of the Section 404 permit, would be based on those wetlands that have a high likelihood of indirect effects as a result of groundwater drawdown. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified during the annual reporting.

Wetlands Abutting the Partridge River

There are approximately 1,478.5 acres of wetlands abutting the Partridge River, which consist of shrub swamps (86 percent of total acres), coniferous bog (13 percent of total acres), and shallow marsh (1 percent of total acres) (PolyMet 2013b). Wetlands abutting Unnamed Creek, Trimble Creek, and Mud Lake Creek within Area 2 (see Figure 4.2.3-2) are presented in Table 5.2.3-6.

Table 5.2.3-6 Wetlands Abutting the Partridge River

Eggers and Reed Class[1]	Wetland Size (acres)	Wetland Size (percent)
Coniferous bog	193.0	13
Shallow marsh	12.1	1
Shrub swamp (including alder thicket or shrub-carr)	1,273.5	86
Total Acres of Wetlands	1,478.5	100

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

The XP-SWMM model identified that the changes in average annual flow (and therefore stage) of the Partridge River would be within the naturally occurring annual variation for the Partridge River. Thus, no potential indirect wetland effects were identified for the wetlands abutting the Partridge River (PolyMet 2013b).

Water Quality Changes

The screening analysis conducted to estimate potential annual deposition of dust, metals, and sulfur to wetlands within and adjacent to the Mine Site and Transportation and Utility Corridor was performed using AERMOD. The estimated deposition from fugitive dust emissions was used to identify wetlands that have the potential for water quality changes. For dust, metals, and sulfur, the following general categories were used for assessing the significance of a modeled deposition rate at a receptor node:

- Less than 100 percent of background: no potential for effects expected.
- Greater than 100 percent of the background value: potential for effects, include in future wetland monitoring.

Given the potential for overestimation of modeled deposition and underestimation of background deposition, and balancing the conservatism when their respective results are combined in this analysis, it seems reasonable to select the wetlands estimated to receive greater than 100 percent of background deposition (a potential doubling of the background deposition) for consideration in potential future monitoring (PolyMet 2013b).

Fugitive Dust/Metals and Sulfide Dust Emissions

At the Mine Site, dust deposition was concentrated relatively close to the ore loading area near the southern portion of the ambient air boundary. All receptors have model-estimated dust deposition of 25 percent or less of the effects-level background of 365 g/m^2/year) (see Figure 5.2.3-16). The highest model-estimated metal and sulfur depositions at the Mine Site were in two defined areas, which include the ore loading area and at the east end of the Category 2/3 Stockpile (see Figure 5.2.3-17). All of the receptor nodes with the highest model-estimated deposition rates were located within the ambient air boundary.

Of the 19,914 acres of wetlands identified within the Mine Site receptor grid, deposition modeling results indicated that 234 acres of wetlands could be potentially indirectly affected (modeled metal deposition rates greater than 100 percent of background). Of the 234 acres of wetlands, 228 acres (97 percent) would be located within the Mine Site ambient air boundary (PolyMet 2013b). The 234 acres of wetlands should be included in any future monitoring to be conducted for the NorthMet Project Proposed Action. The deposition modeling results for dust, metals, and sulfur would likely not have an adverse effect on wetlands; however, the modeling only indicated those areas that had deposition rates greater than 100 percent of background deposition.

The potential release of dust from railcars transporting ore from the Mine Site to the Plant Site was addressed in an Air Quality IAP Workgroup that concluded potential wetland effects would not be significant and, therefore, air modeling was not performed (PolyMet 2013b). Wetlands that have contributing watersheds that include no segments of the railway (e.g., many of the wetlands uphill to the north of the rail corridor) were identified as having no potential indirect effects from rail spillage. Wetlands immediately abutting the railway and whose watersheds included the rail centerline were identified as potentially being affected, although the effects may not extend to the full area of the wetland. Wetlands that have contributing watersheds, which include natural areas that are larger than 675 square meters per meter of track (one-sided) in the contributing watershed, were identified as having no potential indirect effects. Approximately 543 acres of wetlands along the railroad corridor could be potentially indirectly affected by the NorthMet Project Proposed Action.

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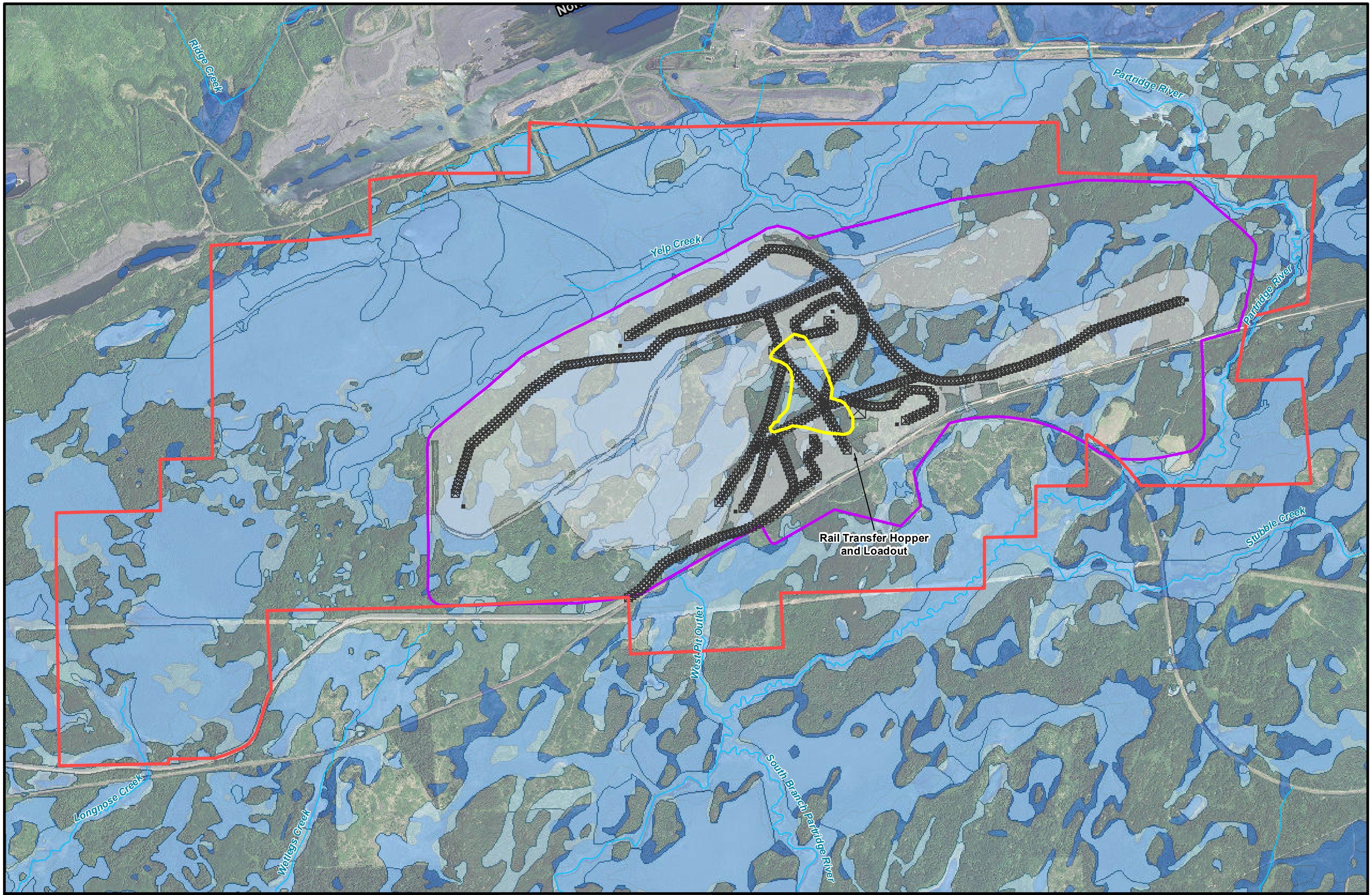

Ambient Air Boundary
Extent of Highest Estimated Deposition Receptors with Deposition of 25% of Background
Mine Site
Disturbed Area
Volume Sources (Roads)
Wetlands
NWI Wetland
Stream/River

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0 1,000 2,000 4,000 Feet

Figure 5.2.3-16

Model - Estimated Dust Deposition Compared to Background Effects Level - Mine Site

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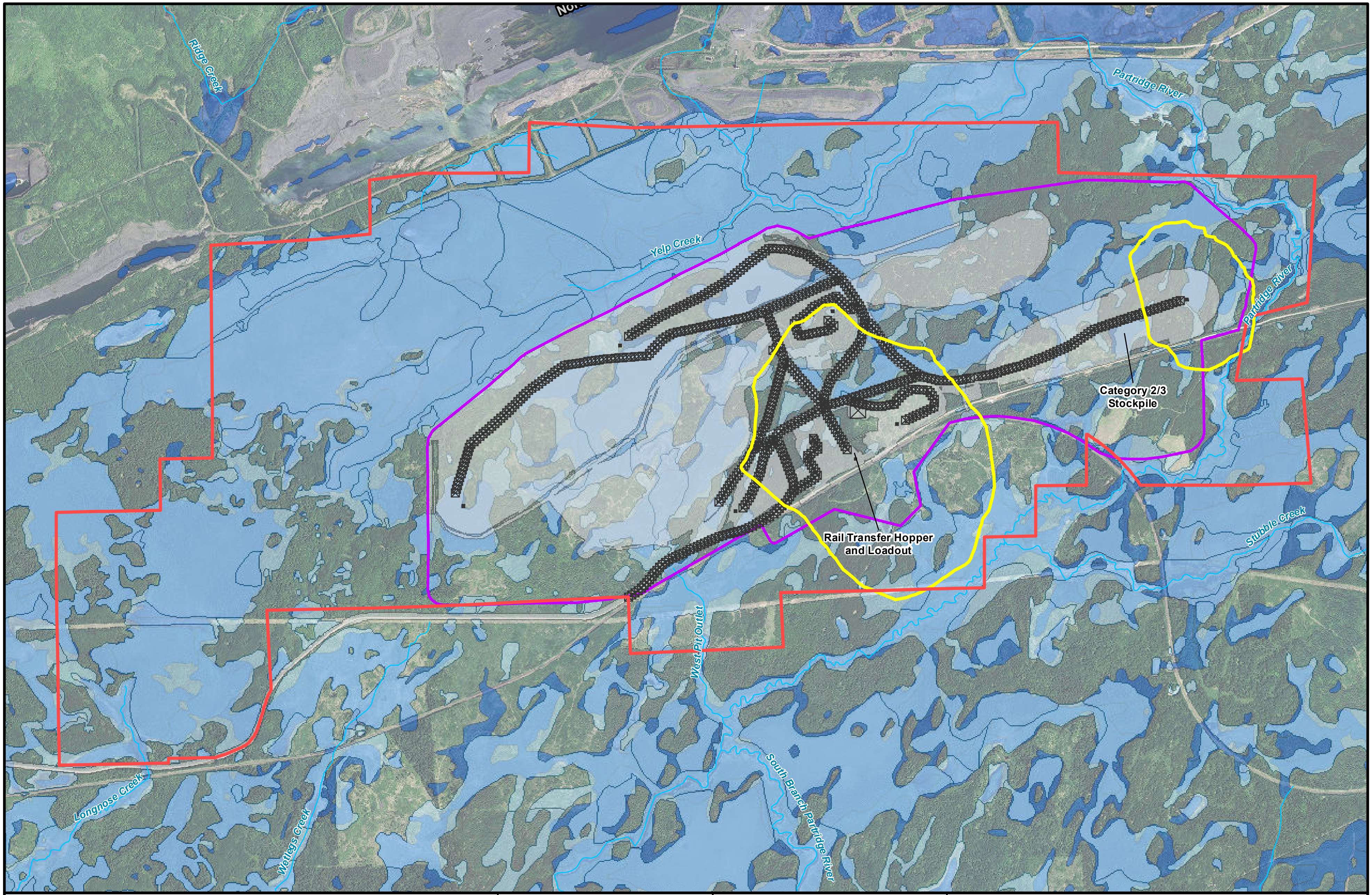

Ambient Air Boundary
Extent of Highest Estimated Deposition Receptors with Deposition of 100% of Background
Mine Site
Disturbed Area
Volume Sources (Roads)
Wetlands
NWI Wetland
Stream/River

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0 1,000 2,000 4,000 Feet

Figure 5.2.3-17
Model - Estimated Metal Deposition Compared to Background Effects Level - Mine Site
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Leakage from Stockpiles/Mine Features and Seepage from Mine Pits

The stockpiles, mine pits, and other mine features (e.g., WWTF) are located within the Partridge River Watershed. Water containing constituents generated in the waste rock stockpiles and mine pits has the potential to enter the shallow groundwater system via potential leakage through the liners (e.g., stockpiles and WWTF equalization basins) or seepage from the pits. The leakage or seepage that enters groundwater would then be transported toward the Partridge River along groundwater flowpaths. There are five groundwater flowpaths connecting the mine features to the Partridge River, which include: East Pit – Category 2/3 flowpath, Ore Surge Pile flowpath, WWTF flowpath, Overburden Storage and Laydown Area flowpath, and West Pit flowpath. Because the water quality within these flowpaths has the potential to change as a result of the NorthMet Project Proposed Action, these same flowpaths were considered in the assessment of potential indirect wetland effects associated with leakage or seepage from mine features (PolyMet 2013b).

Water quality modeling results indicate groundwater quality along each flowpath would change from existing conditions. It was conservatively assumed that these changes may cause potential indirect effects to the character, function, and quality of groundwater-fed wetlands; therefore, it was also assumed that all downgradient groundwater-fed wetlands located within the five Mine Site surficial aquifer flowpaths may have potential indirect wetland effects related to water quality changes as a result off leakage/seepage from mine features (PolyMet 2013b). Approximately 66 percent of the wetlands within the flowpaths are classified as dominantly groundwater-fed while 33 percent of the wetlands are supported only by precipitation (see Table 5.2.3-7). This analysis indicates areas that can be conservatively assumed to have potential indirect effects due to changes in groundwater quality. These specific wetland areas are identified for consideration in future monitoring to be conducted during facility operations.

Table 5.2.3-7 Wetlands within the Mine Site Groundwater Flowpaths

Eggers and Reed Class[1]	Hydrology	West Pit	Overburden Storage and Laydown Area	WWTF	Ore Surge Pile	Category 2/3 Stockpile
Coniferous bog (Minerotrophic)	Precipitation/ Groundwater	0.04	0.0	0.0	0.0	6.3
Coniferous bog (Ombrotrophic)	Precipitation	16.5	0.0	0.0	0.0	148.2
Coniferous swamp	Groundwater	0	2.9	20.1	10.2	0.04
Deep marsh	Groundwater	4.9	0.0	0.0	0.0	0.0
Open bog	Precipitation	0.0	0.0	0.0	0.0	8.9
Sedge/wet meadow	Groundwater	0.0	0.0	0.0	0.0	1.2
Shallow marsh	Groundwater	3.4	0.1	0.0	0.0	5.5
Shrub Swamps (including alder thicket and shrub-carr)	Groundwater	90.5	47.7	18.8	27.6	103.1
Total Acres of Wetland		115.3	50.7	38.9	37.8	273.2

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

The Partridge River currently represents the primary discharge location for shallow groundwater at the Mine Site. During operations, reclamation, and long-term closure, groundwater in areas south of the mine pits would continue to discharge to the Partridge River while groundwater in areas north of the mine pits would discharge to the mine pits. The amount of groundwater discharge to surface water and wetlands between the mine features and the Partridge River would be expected to be minimal relative to the amount of groundwater discharge to the Partridge River itself. Significant quantities of groundwater are not expected to discharge to the wetlands because of the very low hydraulic conductivities of the underlying peat layers. The leakage/seepage analysis could not indicate or suggest that an effect or adverse effect would occur on wetlands; however, the analysis only indicated those areas that could be conservatively assumed to have a potential indirect effect due to changes in groundwater (PolyMet 2013b).

The potential release of dust from railcars transporting ore from the Mine Site to the Plant Site was addressed in the May 6, 2011, Air IAP Summary Memo:

> The air IAP group concluded that there would be minimal air impacts from any dust generated from ore hauled in the railcars due to the coarse nature of the ore.

Based on this conclusion, air modeling of potential release of dust from railcars will not be performed because the potential wetland effects would not be significant.

The air IAP group concluded that any dust generated from ore hauled in railcars would be coarse in nature (i.e., relatively large particles). These larger particles would tend to deposit near the railcar and not be dispersed to any great extent. An estimate of the spillage of ore fines along the rail corridor is shown in Section 8.5.3 of Reference 7 (within PolyMet 2011o). Assuming that all spillage of the coarse material would occur in a 2-meter-wide strip on both sides of the centerline of the railway (total width equals 4 meters) over the entire haul distance after loading (approximately 8 miles or 13,000 meters), results in approximately 0.11 kg/m^2 of ore fines annually or 2.14 kg/m^2 for the 20-year NorthMet Project Proposed Action. This equates to 0.002 inch of depth annually or 0.05 inches for the 20-year NorthMet Project Proposed Action.

Dunka Road Effects

Loaded mine haul trucks would not travel on the Dunka Road. Empty mine haul trucks would only travel on Dunka Road when they are in need of maintenance at the Area 1 Shop. The total one-way trips per year have been estimated to be 44 trips. Given the low traffic volumes (less than one trip per week) and that the ore trucks would likely be empty; no potential indirect wetland effects were identified for wetlands abutting Dunka Road (PolyMet 2013b).

5.2.3.2.3 Plant Site Direct Wetland Effects

PolyMet proposes to reuse the former LTVSMC processing plant and Tailings Basin. The processing plant is located on uplands with no wetland resources present. The existing constructed plant reservoir located east of the concentrator is not regulated as a wetland. Therefore, no direct wetland effects are anticipated in this portion of the Plant Site.

Direct wetland effects would result from the following Plant Site components: construction of the Tailings Basin, pump station, treated water discharge pipelines, flotation tailings pipeline, Tailings Basin containment system to manage Tailings Basin seepage, rock buttress for stability along the north and east sides of Cell 2E, drainage swale and overflow channel located northeast of Cell 2E, and the Hydrometallurgical Residue Facility.

Direct wetland effects within the Plant Site would total 147.1 acres. These wetlands effects would be caused by fill (12 percent), excavation (31 percent), excavation and fill (less than one percent), and the containment system (58 percent). Table 5.2.3-8 summarizes the directly affected wetlands within the Plant Site by community type while Table 5.2.3-9 identifies the activity that causes the effects expected within the Plant Site. The majority of the wetlands (94 percent) that would be affected are rated as low quality and 6 percent are rated as moderate quality wetlands.

The rock buttress described in Section 3.2.3 and Section 4.2.13 would abut the existing toe of the Tailings Basin. The water containment system would extend approximately 300 ft around the northern and western sides of the Tailings Basin, encapsulating the Tailings Basin, the rock buttress and wetlands between it and the rock buttress. Construction of the Tailings Basin for the NorthMet Project Proposed Action would also result in expansion of the existing eastern footprint onto natural highland. The majority of the affected 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 (PolyMet 2013b). 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 2008b).

Wetlands located outside of the Cliffs Erie Permit to Mine Ultimate Tailings Basin boundary (this boundary is shown on Figure 5.2.3-18 and Figure 5.2.3-19) but within the Hydrometallurgical Residue Facility are included in the direct wetland impact analysis. As previously noted, approximately 28.6 acres of wetlands in the Hydrometallurgical Residue Facility are not subject to state or federal regulations as they are located within an actively permitted waste storage facility. Two wetlands located in the Hydrometallurgical Residue Facility are subject to state or federal regulation covering 7.5 acres and would be directly affected by fill. Both wetlands are shallow marsh wetlands (see Figure 5.2.3-19).

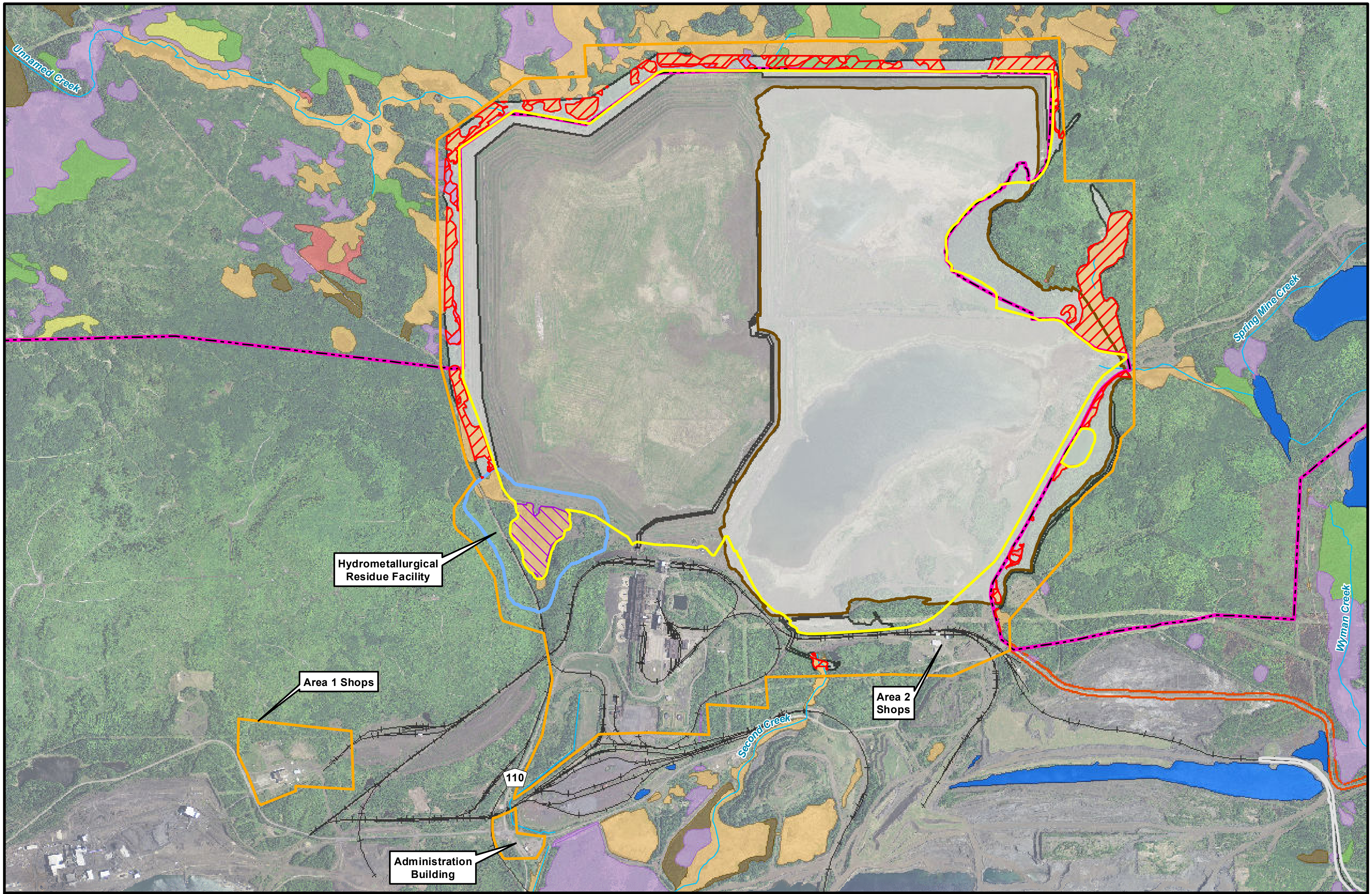
There would be no direct wetland effects along the Colby Lake Water Pipeline Corridor, as there would be no construction within this corridor.

Table 5.2.3-8 Total Projected Direct Wetland Effects for the Plant Site

	Directly Affected Wetlands at the Plant Site		
Eggers and Reed Class[1]	**Acres**	**%**	**No.**
Coniferous bog	0.0	0	0
Coniferous swamp	10.7	7	3
Deep marsh	73.4	50	14
Hardwood swamp	0.0	0	0
Open bog	0.0	0	0
Open Water (includes shallow, open water, and lakes)	0.0	0	0
Sedge/wet meadow	1.4	1	5
Shallow marsh	52.7	36	14
Shrub swamp (includes alder thicket and shrub-carr)	8.9	6	6
Total Direct Effects	147.1	100	42

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.



Plant Site
Directly Affected Wetland
Exempt Wetland
Disturbed Area
Cliffs Erie, LLC Permit to Mine Ultimate Tailings Basin Limit
Area 2
Stream/River
Transportation and Utility Corridor
Railroad Connection
Hydrometallurgical Residue Facility
Existing Railroad

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Deep Marsh & Shallow Marsh
Hardwood Swamp
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

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N W E S

0 1,000 2,000 4,000 Feet

Figure 5.2.3-18
Tailings Basin Wetlands and Direct Wetland Effects
NorthMet Mining Project and Land Exchange PSDEIS
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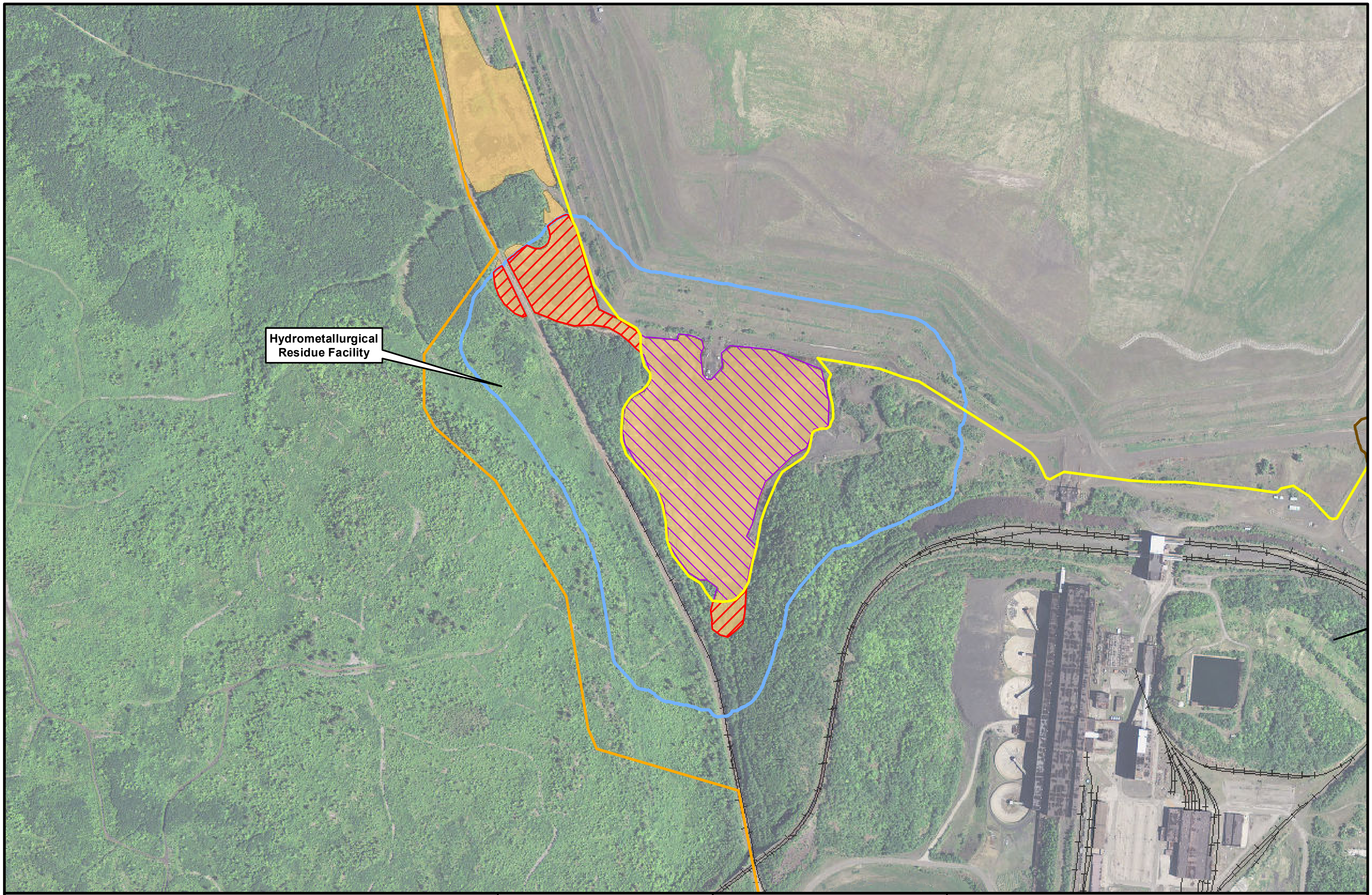

Hydrometallurgical Residue Facility

Cliffs Erie, LLC Permit to Mine Ultimate Tailings Basin Limit

Directly Affected Wetland

Exempt Wetland

Plant Site

Existing Railroad

Stream/River

Eggers & Reed Wetland Types

Coniferous Bog

Coniferous Swamp

Hardwood Swamp

Deep Marsh & Shallow Marsh

Open Bog

Sedge Meadow & Wet Meadow

Shrub Swamps (Alder Thicket & Shrub-Carr)

Shallow, Open Water & Lake

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N W E S

0 250 500 1,000 Feet

Figure 5.2.3-19

Hydrometallurgical Residue Facility Wetlands and Direct Wetland Effects

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Minnesota

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Table 5.2.3-9 Type of Projected Direct Wetland Effects at the Plant Site

	Directly Affected Wetlands at the Plant Site		
Type of Effect	**Acres**	**%**	**No.**
Fill	17.0	12	16
Excavation	45.2	31	1
Fill and Excavation	0.2	<1	1
Containment System	84.7	58	24
Total Direct Effects	147.1	100	42

Source: PolyMet 2013b.

5.2.3.2.4 Plant Site Indirect Wetland Effects

The indirect wetland effects were assessed by identifying wetlands in Area 2 within 500-foot increments beginning at the Plant Site and continuing out to a total of 30,000 feet (see Figure 5.2.3-20). The area of evaluation for the Plant Site indirect wetlands effects included wetlands within Area 2 where wetland type information had been developed and wetlands within and near Second Creek, and does not include the directly affected wetlands. No wetlands are located within the former LTVSMC processing plant; therefore, no indirect wetland effects would occur from its reuse.

Wetland Fragmentation

Construction of the Plant Site features (e.g., containment system) would result in approximately 0.5 acre of wetland fragments. Wetland fragments would result in the following wetland types: shallow marsh (61 percent), deep marsh (35 percent), coniferous swamp (4 percent), and shrub swamps (less than 1 percent) (PolyMet 2013b). No wetland fragmentation would result from the stream flow augmentation activities for Second Creek (PolyMet 2013k).

Changes in Hydrology

There are three surficial aquifer groundwater flowpaths from the Plant Site (see Figure 5.2.3-21), which include: Unnamed Creek (west flowpath), Trimble Creek (northwest flowpath), and Mud Lake Creek (north flowpath). Wetland types within the flowpaths that would have indirect wetland effects resulting from changes in hydrology are presented in Table 5.2.3-10.

In addition, wetlands in and around Second Creek were assessed to determine if any indirect wetland effects associated with stream flow augmentation activities for Second Creek would occur. The area of analysis begins at the origin of Second Creek at the south end of the Tailings Basin Cell 1E, and ends at the east edge of County Highway 666. The majority of the area that was analyzed is located outside the Plant Site and Area 2 boundaries (Figures 5.2.3-18 and 5.2.3-20). There are approximately 298.9 acres of wetlands within the Second Creek assessment area: shrub swamp (44 percent); shallow marsh (35 percent); hardwood swamp (7 percent); deep marsh (7 percent); coniferous swamp (6 percent); wet meadow (less than 1 percent); and open water (less than 1 percent) (PolyMet 2013k).

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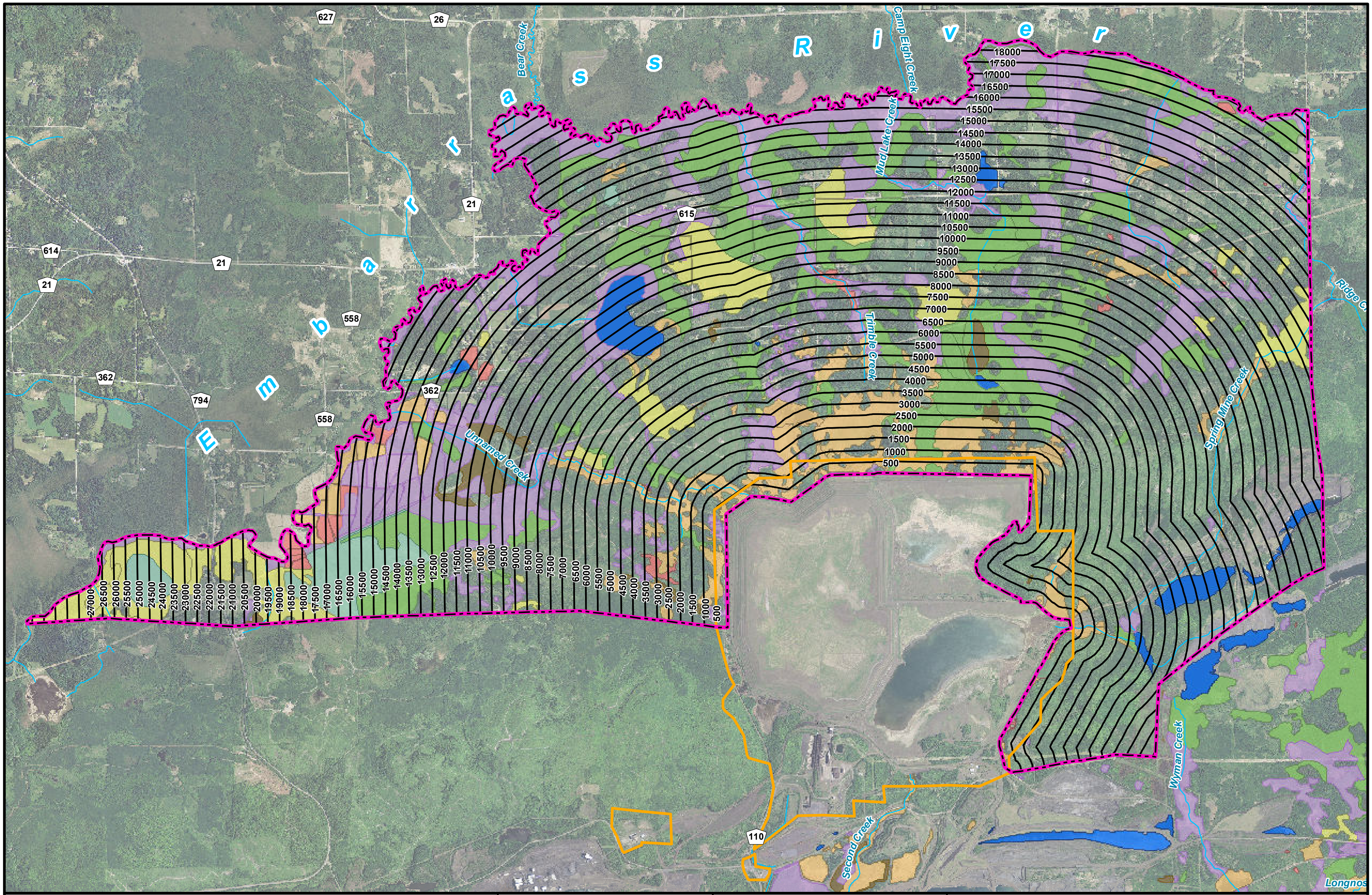

500 ft Increments
Area 2
Plant Site
Stream/River

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Hardwood Swamp
Open Bog
Deep Marsh & Shallow Marsh
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N W E S

0 0.25 0.5 1 1.5 Miles

Figure 5.2.3-20

Wetlands within 500 ft Increments at the Plant Site

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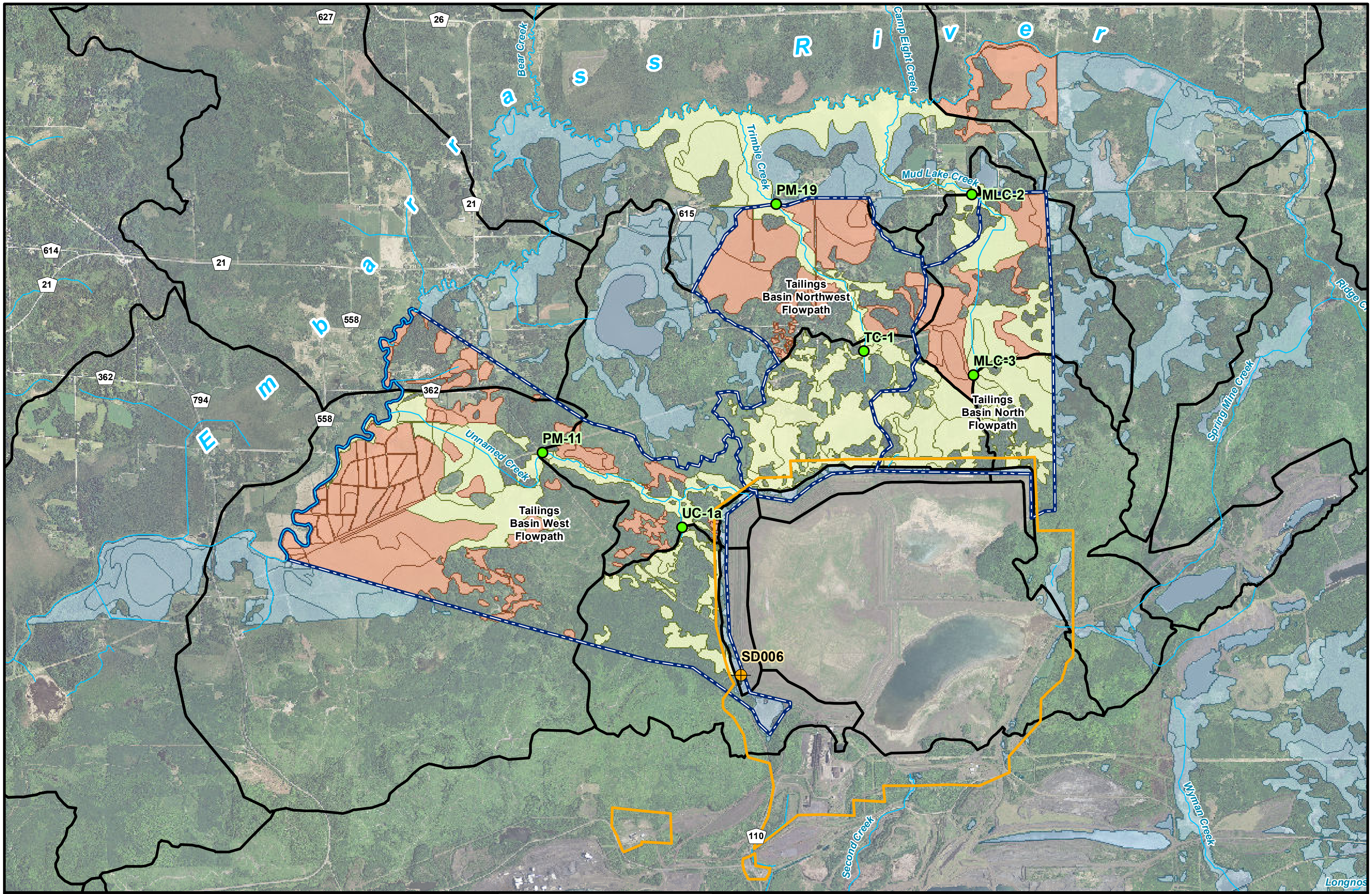

Plant Site
Surface Water Monitoring Location
Approximate Location of NorthMet Project Surface Water Discharge
Groundwater Flow Path
Embarrass River Subwatershed
Wetlands
Wetlands with Potential for Indirect Impacts
Surface Water and Groundwater
Groundwater Only
Stream/River

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N E S W

0 0.25 0.5 1 1.5 Miles

Figure 5.2.3-21
Wetlands within Groundwater Flowpaths at the Plant Site
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Table 5.2.3-10 Wetlands within the Plant Site Flowpaths

Eggers and Reed Class[1]	Hydrology	Unnamed Creek (west flowpath) Acres	Trimble Creek (northwest flowpath) Acres	Mud Lake Creek (north flowpath) Acres
Coniferous bog (Ombrotrophic)	Precipitation	37.6	196.6	58.1
Coniferous swamp	Groundwater	375.5	308.4	630.6
Deep marsh	Groundwater	130.9	97.6	125.8
Hardwood swamp	Groundwater	126.1	0.0	40.9
Open bog	Precipitation	157.5	0.0	0.0
Open water	Groundwater	8.3	0.0	7.4
Sedge/wet meadow	Groundwater	99.3	17.7	0.4
Shallow marsh	Groundwater	196.5	225.8	124.1
Shrub swamps (including alder thicket and shrub-carr)	Groundwater	721.5	236.9	144.9
	Total acres of wetland	1,853.0	1,083.0	1,132.3

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

The Tailings Basin containment system would collect approximately 90 percent of the seepage from the Tailings Basin to groundwater and 100 percent of the seepage from the Tailings Basin to surface water. All of the surface flow that currently upwells near the west, northwest, and north toes of the Tailings Basin would be captured and treated by the WWTP and then discharged to the tributaries to prevent significant hydrologic effects due to reduction in flow. Additionally, during periods when there would be insufficient flow from the WWTP, water would be transferred from Colby Lake to augment the discharge to the tributaries in order to prevent significant hydrologic effects. To the west, the discharge(s) would be directed to a location near the existing surface discharge SD006 (see Figure 5.2.3-21). To the northwest and north, the discharge(s) would be spigotted at multiple locations along the downstream side of the Tailings Basin containment system to add flow to the adjacent wetlands, similar to what occurs under existing conditions (PolyMet 2013b). Table 5.2.3-11 shows the expected amount of discharge needed on an average annual basis; discharge needs can be met by either water from the WWTP or from Colby Lake. For a detailed discussion of seepage from the Plant Site please refer to Section 5.2.2.

Seepage from the south side of the Plant Site is generally restricted by bedrock outcrops and does not contribute to the groundwater flow south of the Plant Site. All of the seepage from the south side of the Plant Site is surface water, thereby forming the headwaters of Second Creek. There would be no potential indirect effects on wetlands in and around Second Creek as a result of changes in groundwater flow (PolyMet 2013k).

Table 5.2.3-11 Determination of Combined Flow Requirement for the Watersheds from the Wastewater Treatment Plant and Colby Lake

Type of Flow Requirement	Unnamed Creek (PM-11) (west flowpath) gpm	Trimble Creek (TC-1) (northwest flowpath) gpm	Mud Lake Creek (MLC-3)[5] (north flowpath) gpm
Total annual average surface flow[1]	1,180	1,888	665
Expected future contribution from the watershed[2]	664	599	439/734
Minimum requirement from WWTP/Colby Lake[3]	280	911	93/0
Maximum allowable from WWTP/Colby Lake[4]	752	1,667	359/64
Percent of WWTP discharge before the drainage swale is constructed	17%	54%	6%
Percent of WWTP discharge after the drainage swale is constructed	18%	57%	0%

Source: PolyMet 2013b.

1 Existing annual average flow in the tributary.
2 The future contribution from the watershed decreases because the Tailings Basin containment system, which is away from the toes of the Tailings Basin, removes watershed area and any runoff from the outer banks of the Tailings Basin.
3 80% of the existing total annual average surface flow, less the expected future watershed contribution.
4 120% of the existing total annual average surface flow, less the expected future watershed contribution.
5 X / Y values: X indicates the flow values before the drainage swale is in place; Y indicates the flow values after the watershed area to Mud Lake Creek is increased (from 1.34 to 2.24 mi^2) because of the construction of the drainage swale at time greater than 7 years.

Changes in Hydrology due to Drawdown or Surcharge

The augmentation described above has been designed such that the average annual water yield at the toe of the Tailings Basin would be within plus or minus 20 percent of the NorthMet Project No Action Alternative, which is within the range of annual variability in precipitation as well as stream flow, within the Partridge River and Embarrass River watersheds. Therefore, changes to downstream hydrology, including adjacent wetlands, would be expected to be within the range of that typically observed due to natural variability (PolyMet 2013b; PolyMet 2013d). No potential indirect wetland effects would be anticipated for the wetlands abutting Second Creek (PolyMet 2013k).

Potential indirect effects on Mud Lake Creek, Trimble Creek, and Unnamed Creek due to reduced or increased seepage at the toe of the Tailings Basin are greatest immediately downstream of the toe, where seepage and augmentation account for nearly all the water yield. Downstream of the toe, the indirect effects on these three creeks would be reduced as the watershed area tributary to that location increases, and the portion of total water yield derived from runoff increases. Therefore, hydrologic effects diminish as distance from the Tailings Basin increases. Wetlands further from the Tailings Basin would likely experience less potential for indirect effects due to hydrologic changes (PolyMet 2013b).

Wetland hydrology is a complex mix of precipitation, surface runoff, and, in some cases, groundwater. Despite the use of augmentation to mitigate effects, the response of complex natural systems to human disturbances could only be estimated. Therefore, monitoring of wetland hydrology and vegetation communities would be the most appropriate way to document the extent and magnitude of wetland responses to the NorthMet Project Proposed Action.

Please refer to Section 5.2.3.2.2, Changes in Hydrology Due to Drawdown subsection, for the hydrologic wetland sensitivity assessment that was performed to estimate how wetland communities would respond to groundwater drawdown by assuming that they would change to drier native plant communities or variants of the original community.

Wetlands Abutting Unnamed Creek, Trimble Creek, and Mud Lake Creek

There are approximately 2,754.8 acres of wetlands abutting Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek, which include shrub swamps, coniferous swamp, hardwood swamp, shallow marsh, deep marsh, and sedge/wet meadow (see Figure 4.2.3-5) are presented in Table 5.2.3-12.

Table 5.2.3-12 Wetlands Abutting Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek

	Unnamed Creek		Trimble Creek		Mud Lake Creek		Second Creek		Total Wetlands Abutting Creeks	
Eggers and Reed Class[1]	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Coniferous swamp	16.3	3	130.3	15	474.3	41	0.0	0	620.9	23
Deep marsh	53.8	10	5.9	1	0	0	14.3	8	74.0	3
Hardwood swamp	98.1	19	0	0	31.0	3	0.0	0	129.1	5
Sedge/wet meadow	0	0	17.7	2	0	0	0.0	0	17.7	1
Shallow marsh	85.8	16	36.7	4	0	0	45.8	26	168.3	6
Shrub swamp (including alder thicket or shrub-carr)	273.0	52	695.8	78	657.1	57	118.8	66	1744.7	63
Total Acres of Wetlands	527.1	100	886.4	100	1,162.4	100	178.9	100	2,754.8	100

Sources: PolyMet 2013b; PolyMet 2013k.

[1] Eggers and Reed 1997.

Water management at the Plant Site would consist of flow augmentation immediately downstream of the Tailings Basin containment system to minimize hydrologic effects on downstream watercourses (PolyMet 2013b). The hydrologic analysis (see Section 5.2.2) estimated that the changes in average annual flow of Unnamed Creek, Trimble Creek, and Mud Lake Creek would be within the annual variability that naturally occurs within the Embarrass River Watershed. Therefore, no potential indirect wetland effects were identified for the wetlands abutting Unnamed Creek, Trimble Creek, and Mud Lake Creek (PolyMet 2013b). The hydrologic analysis (see Section 5.2.2) estimated that the changes in average annual flow of Second Creek would be within the annual variability that naturally occurs within the Partridge and Embarrass River Watersheds. Therefore, no potential indirect wetland effects were identified for the wetlands abutting Second Creek (PolyMet 2013k).

Water Quality Changes

The screening analysis conducted to estimate potential annual deposition of dust, metals, and sulfur to wetlands within and adjacent to the Plant Site was performed using AERMOD. The estimated deposition from fugitive dust emissions was used to identify wetlands that have the potential for water quality changes. For dust, metals, and sulfur, the following general categories were used for assessing the significance of a modeled deposition rate at a receptor node:

- Less than 100 percent of background: no potential for effects expected.
- Greater than 100 percent of the background value: potential for effects, include in future wetland monitoring.

Given the potential for overestimation of modeled deposition and underestimation of background deposition, and balancing the conservatism when their respective results are combined in this analysis, it seems reasonable to select the wetlands estimated to receive greater than 100 percent of background deposition (a potential doubling of the background deposition) for consideration in potential future monitoring (PolyMet 2013b).

Fugitive Dust/Metals and Sulfide Dust Emissions

At the Plant Site, dust deposition was highest in three locations: southwest corner, northwest of the Plant Site; southeast corner; and the northeast corner, towards Area 5. All receptors have model-estimated dust deposition of 50 percent or less of the effects-level background of 365 $g/m^2/yr$ (see Figure 5.2.3-22). At the Plant Site, there would be two locations showing model-estimated deposition rates greater than 100 percent of background deposition: 1) approximately the southern and western two-thirds of the basin and 2) a small area on the northern and eastern portion of the ambient air boundary (see Figure 5.2.3-23). Approximately 90 percent of the receptor nodes with the highest model estimated deposition rates (rates greater than 100 percent of background deposition) are located within the ambient air boundary. The remaining 10 percent of the receptor nodes with the highest modeled deposition are located to the south and east of the Plant Site outside of the ambient air boundary (PolyMet 2013b). No potential indirect wetland effects from fugitive dust to Second Creek would occur (PolyMet 2013k).

Of the 25,846 acres of wetlands identified within the Plant Site receptor grid, deposition modeling results indicate that 193.9 acres of wetland could be potentially indirectly affected (modeled metal deposition rates greater than 100 percent of background). Of the 201, 58.8 acres would be located within the Plant Site ambient air boundary (PolyMet 2013b; PolyMet 2013k). The 193.9 acres of wetlands should be included in any future monitoring to be conducted for the NorthMet Project Proposed Action. The deposition modeling results for dust, metals, and sulfur would likely not have an adverse effect on wetlands; however, the modeling only indicated those areas that had deposition rates greater than 100 percent of background deposition (PolyMet 2013b; PolyMet 2013k).

Water Quality Changes

The NorthMet Project Proposed Action is predicted to meet all water quality evaluation criteria, or not worsen conditions where contamination already exceeds the criteria. The collection of existing seepage by the containment system and augmentation with Colby Lake and WWTP effluent water would generally improve downstream water quality relative to current conditions.

Effects that would occur on surface water and groundwater quality are discussed in Section 5.2.2. Therefore, no indirect effects on wetlands are expected relating to water quality.

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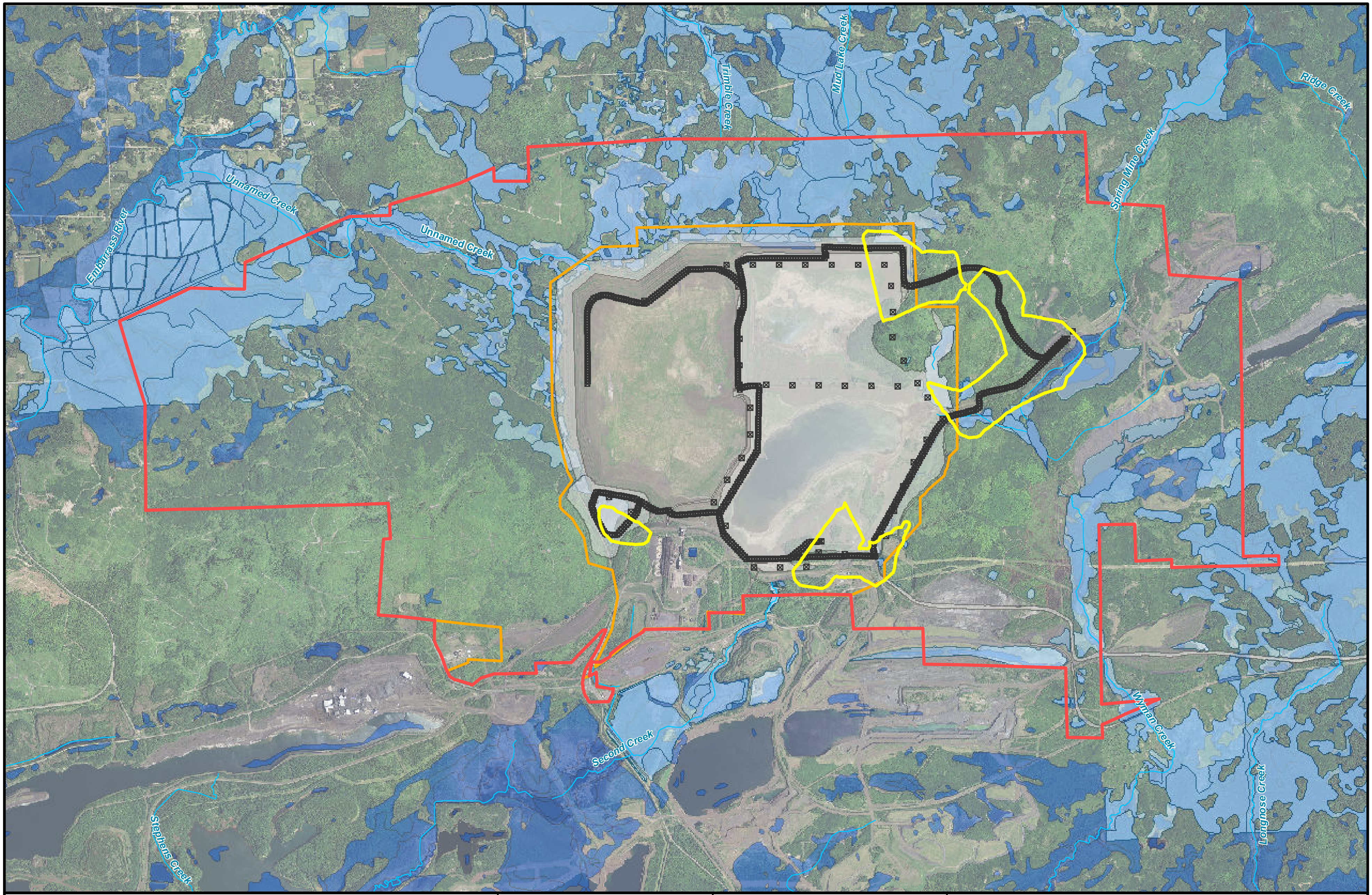

Ambient Air Boundary
Extent of Highest Estimated Deposition Receptors with Deposition of 50% of Background
Plant Site
Disturbed Area
Volume Sources (Roads)
Wetlands
NWI Wetland
Stream/River

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0 0.25 0.5 1 Miles

Figure 5.2.3-22
Model - Estimated Dust Deposition Compared to Background Effects Level - Plant Site
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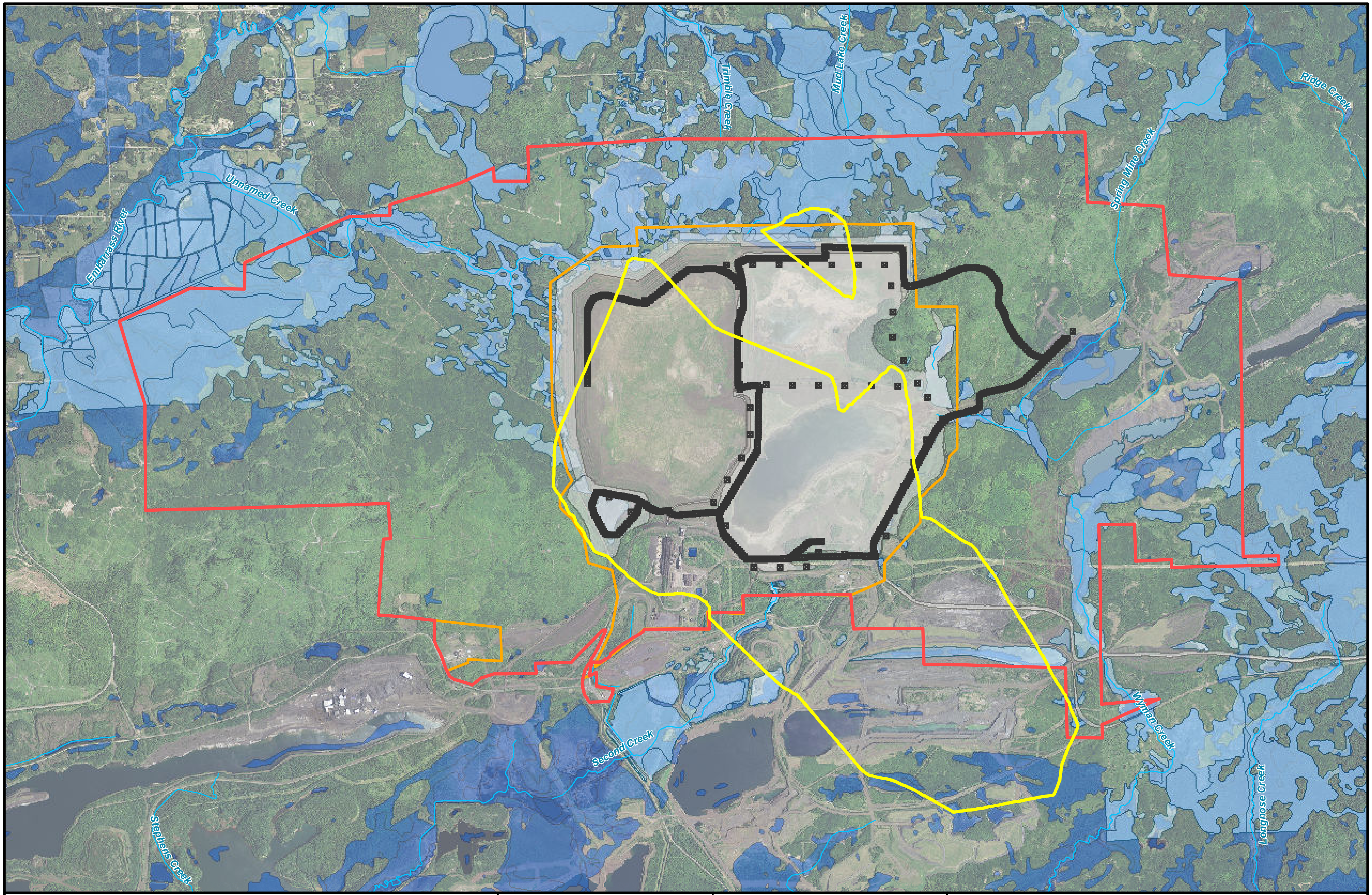

Ambient Air Boundary
Extent of Highest Estimated Deposition Receptors with Deposition of 100% of Background
Plant Site
Disturbed Area
Volume Sources (Roads)
Wetlands
NWI Wetland
Stream/River

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N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-23

Model - Estimated Metal Deposition Compared to Background Effects Level - Plant Site

NorthMet Mining Project and Land Exchange PSDEIS

Minnesota

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Wetland areas that would be potentially affected by water quality changes are shown in Figure 5.2.3-21 and listed in Table 5.2.3-13. Note that within this section, the term groundwater and surface water refer to the path by which NorthMet Project Proposed Action water leaves the Tailings Basin (e.g., potential effects from Tailings Basin groundwater seepage that discharges to surface water at a downstream location are classified as a potential effect due to changes in groundwater quality).

Table 5.2.3-13 Wetland Areas Indirectly Affected by Changes in Water Quality

Wetland Area Potentially Affected by Changes in Water Quality	Mud Lake Creek (North) Acres	Trimble Creek (Northwest) Acres	Unnamed Creek (West) Acres	Downstream of Groundwater Flowpaths(3) Acres	Total Acres
Groundwater Quality[1]	296.5	514.0	1,162.1	--	1,972.7
Surface Water and Groundwater Quality[2]	835.8	568.9	690.9	570.2	2,665.7
Total	1,132.3	1,082.9	1,853.0	570.2	4,638.4

Source: PolyMet 2013b.

1 Groundwater refers to water leaving the Tailings Basin within the surficial aquifer. Effects resulting from the discharge of that seepage to surface water have been considered an effect due to groundwater in the analysis.

2 All areas potentially affected by changes in surface water quality have also been potentially affected by changes in groundwater quality.

3 Potentially affected wetlands are located along Trimble Creek and Mud Lake Creek, but outside of groundwater flowpaths (see also Footnote (1)).

Wetlands abutting the three creeks that may be indirectly affected (4,068.2 acres) by changes in groundwater quality are shown on Figure 5.2.3-21. The effects on groundwater quality diminish as distance from the Tailings Basin increases, as the relative portion of total groundwater that originates from the Tailings Basin decreases (Section 5.2.2). It has been determined that the amount of Tailings Basin seepage remaining in the surficial aquifer would be small; therefore, the potential for indirect effects as a result of changes in groundwater quality are anticipated to be small.

Potential effects from changes in groundwater quality may also occur in wetlands abutting tributary streams (all reaches of Unnamed Creek, Trimble Creek, and Mud Lake Creek) into which affected groundwater would discharge (see Figure 5.2.3-21). Wetlands abutting these streams and outside of the modeled groundwater flowpaths resulted in an additional 570.2 acres of potential indirect effects due to changes in groundwater quality (PolyMet 2013b).

Potential indirect effects from changes in surface water quality would also likely occur in wetlands within the surface watersheds immediately downstream of the Tailings Basin, which includes watersheds upstream of modeling locations UC-1a, TC-1, and MLC-3 (see Figure 5.2.3-21). The potential indirect effects from changes in surface water quality include 1,158 acres of wetlands (all of which would also likely be potentially indirectly affected by changes in groundwater quality). Downstream of these locations, potential indirect effects due to changes in surface water quality are limited to wetlands abutting the tributary streams. These areas include an additional 1,505 acres of wetlands (all of which may also be potentially indirectly affected by changes in groundwater quality) (PolyMet 2013b).

As with effects from changes in groundwater quality, potential effects as a result of changes in surface water quality would be expected to diminish as distance from the Tailings Basin increases and flows originating from the NorthMet Project Proposed Action are diluted by natural runoff.

5.2.3.2.5 Summary of NorthMet Project Proposed Action Direct and Indirect Wetland Effects

Direct wetland effects for the NorthMet Project Proposed Action are summarized in Table 5.2.3-14. Of the 177 wetlands within the NorthMet Project area, 126 wetlands would be directly affected, totaling 912.5 acres of direct wetland effect. The Mine Site would contain the majority of the direct wetland effects. The majority of the direct effects would occur as a result of a combination of filling and excavation (65 percent) (see Table 5.2.3-15).

Table 5.2.3-14 Total Projected Direct Wetland Effects for the NorthMet Project Proposed Action

	Directly Affected Wetlands		
Eggers and Reed Class[1]	**Acres**	**%**	**No.**
Coniferous bog	509.1	56	24
Coniferous swamp	82.6	9	17
Deep marsh	73.5	8	15
Hardwood swamp	12.5	1	2
Open bog	7.6	1	2
Open Water (includes shallow, deep, open water, and lakes)	0.0	0	0
Sedge/wet meadow	39.6	4	10
Shallow marsh	76.7	8	23
Shrub swamp (includes alder thicket and shrub-carr)	110.8	12	31
Total Direct Effects	912.5	100	126

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

Table 5.2.3-15 Type of Projected Direct Wetland Effects for the NorthMet Project Proposed Action

	Directly Affected Wetlands		
Type of Effect	**Acres**	**%**	**No.**
Fill	101.5	11	64
Excavation	133.1	15	15
Fill and Excavation	593.2	65	23
Containment System	84.7	9	24
Total Direct Effects	912.5	100	126

Source: PolyMet 2013b.

Indirect wetland effects from the NorthMet Project Proposed Action would result from one of the following six factors: 1) wetland fragmentation, 2) change in wetland hydrology from changes in watershed area, 3) changes in wetland hydrology from groundwater drawdown, 4) water quality changes related to deposition of dust, 5) water quality changes related to ore spillage along the Transportation and Utility Corridor, and 6) changes in water quality related to leakage from stockpiles/mine features and seepage from mine pits. A rating system (0-6) was developed for the wetlands based on the number of factors that may potentially affect it. Wetlands that were not indirectly affected were rated as zero and wetlands that were indirectly affected by all six factors were rated as a six; however, no wetlands were rated as a six (PolyMet 2013b). Potential indirect wetland effects are presented in Table 5.2.3-16.

Table 5.2.3-16 Summary of Projected Indirect Wetland Effects for the NorthMet Project Proposed Action

	Total Indirect Wetlands (based on the method of wetlands *crossing* analog impact zones)		**Total Indirect Wetlands (based on the method of wetlands *within* analog impact zones)**	
Rating[1]	**Acres**	**%**	**Acres**	**%**
1	4,108.7	55	3,470.6	53
2	3042.9	41	2,813.1	43
3	245.3	3	206.0	3
4	15.9	<1	8.1	<1
5	0.3	<1	0.3	<1
Total Acres of Indirect Wetland Effect	7,413.1	100	6,498.1	100

Sources: PolyMet 2013b; PolyMet 2013k.

[1] A wetland may be potentially indirectly affected by none of the six factors or up to a maximum of six, with different combinations of factors possible. A rating was developed for the wetlands based on the number of factors that may potentially affect it – from No Effect (0 factors) to 6 (all six factors potentially indirectly affecting the wetland).

5.2.3.3 NorthMet Project Proposed Action Avoidance, Minimization, Mitigation, and Monitoring Measures

This section discusses measures that were taken to avoid and minimize wetland effects, evaluates PolyMet's proposed wetland mitigation for unavoidable effects, discusses other potential mitigation measures that may benefit wetlands, and identifies key elements of a wetland monitoring plan.

5.2.3.3.1 Wetland Avoidance and Minimization

PolyMet proposes to avoid and minimize wetland effects through a number of measures that are incorporated into the proposed mine 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 saturated overburden and temporary stockpiles that contain membrane liners, which were separate in the original NorthMet Project Proposed Action design. The Overburden Storage and Laydown Area would only store peat and unsaturated overburden (PolyMet 2013c). By reducing the footprint of the Overburden Storage and Laydown Area and stockpiles, direct wetland effects were reduced. Similarly, PolyMet proposes to move the Category 4 Stockpile to the footprint of the Central Pit, which would be mined later and thus avoid additional direct wetland effects. Reactive waste rock stockpiles would be lined, and stormwater runoff that contacted reactive rock would be contained to help prevent water quality-related effects on adjacent wetlands. In addition, hydrologic effects 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/layout has been re-configured to have fewer haul roads and locations thereby reducing land and wetland disturbance and truck distance to be driven. Haul road construction would include placement of large rocks as a foundation to allow shallow subsurface groundwater flowpaths in the wetlands to be maintained within the active areas of the Mine Site between the pits and stockpiles.

Specifically, utilizing existing Plant Site infrastructure, the existing LTVSMC Tailings Basin, and the Transportation and Utility Corridor all serve as avoidance measures since building these on undeveloped greenfield sites could affect at least hundreds of acres of additional wetlands. Reusing existing infrastructure limits wetland effects from these activities to previously disturbed areas. Additionally, cutoff berms/walls, trenches, and sump and pump systems would be used to collect current and future surface seepage from around the toe of the Tailings Basin (PolyMet 2011m). This surface seepage would ultimately be re-routed to the Tailings Basin, thus avoiding or minimizing discharges to surrounding wetlands. Construction of the containment system, however, would reduce the amount of seepage flowing to four tributaries of the Embarrass River (PolyMet 2013c). Stream flow would be augmented using WWTP effluent and water from Colby Lake so that the target annual average flow would be met.

5.2.3.3.2 Wetland Mitigation

As previously noted, wetlands are protected under state and federal laws, including the WCA (*Minnesota Rules* Chapter 8420), *Minnesota Rules*, part 7050.0186, and the CWA Sections 401 and 404. In addition, some wetlands are also designated as Minnesota Public Waters and subject to the Public Waters Work Permit Rules (*Minnesota Rules* Chapter 6115).

Both the state and federal wetland regulations require that a permit, approval, and/or certification be issued by the regulatory agency for wetland effects as defined by the respective regulations. The USACE St. Paul District is the permitting authority for federal CWA Section 404 permits; the MDNR Division of Lands and Minerals administers the WCA approval process as part of the Permit to Mine (*Minnesota Rules*, part 8420.0200, subp. 1D); and the MPCA has authority to issue a CWA Section 401 water quality certification on the CWA Section 404 permit. The CWA Section 404 permit and the Permit to Mine both have financial assurance mechanisms to ensure successful completion of the NorthMet Project Proposed Action. Financial assurance can be a condition of a permit under CWA Section 404, and the MDNR has authority to require a performance bond for compliance with the conditions of the Permit to Mine.

The USACE generally requires compensatory mitigation for adverse effects to aquatic resources. This regulation establishes standards and criteria for the general compensatory mitigation requirements of the Section 404 permit. Specifically 33 CFR 332.3(n)(1) addresses financial assurance stating,

> The district engineer shall require sufficient financial assurances to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with applicable performance standards.

If a Section 404 permit is issued, financial assurances for the NorthMet Project Proposed Action would be required as a condition of that permit. Financial assurance requirements for aquatic resource effects would be based on the size and complexity of the mitigation project, the likelihood of success, past performance of the project's proposer, all costs related to mitigation project development, and the form of financial assurance (e.g., performance bond, letters of credit, or escrow accounts).

Minnesota Rules 8420.0522 outlines the replacement standards for wetlands as regulated under WCA. *Minnesota Rules* 8420.0522, subp. 9(A) and (B) discuss financial assurance requirements for compensatory wetland mitigation stating,

> (A) For wetland replacement that is not in advance, a financial assurance acceptable to the local government unit must be submitted to, and approved by, the local government unit to ensure successful replacement. The local government unit may waive this requirement if it determines the financial assurance is not necessary to ensure successful replacement. The local government unit may incorporate this requirement into any financial assurance required by the local government unit for other aspects of the project.
> (B) The financial assurance may be used to cover costs of actions necessary to bring the project into compliance with the approved replacement plan specifications and monitoring requirements.

The financial assurance requirements would be part of the WCA permitting process for the NorthMet Project Proposed Action.

Section 401 of the CWA requires the MPCA to certify that all projects that receive a federal license or permit are in compliance with state and federal water quality guidelines. Therefore, as part of their review, the MPCA conducts a separate review for compliance with water quality standards and policies and guidelines, which includes mitigation for wetland effects and approval of the wetland replacement ratios. This review process must be completed before the USACE Section 404 permit can be issued.

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 affected 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 affected 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 credits of compensatory mitigation for every 1 acre of wetland loss) in the northeastern portion of Minnesota where the NorthMet Project area 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 eight-digit hydrologic unit code watershed, as the authorized wetland effects or bank credits are purchased within the same bank service area—reduce ratio by 0.25.

- In-advance incentive: 1) a project-specific mitigation site must have wetland hydrology and initial hydrophytic vegetation established at least one full growing season in advance of the authorized wetland effects; or 2) USACE-approved 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 affected—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), requirements for mitigation can exceed the 1.5:1 mitigation ratio if the affected wetlands provide rare or exceptional functions.

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 affected 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 percent or more of pre-settlement wetlands exist, including St. Louis County, minimum replacement ratio requirements are as determined by mitigation location, type, and timing (see Table 5.2.3-17). The actual replacement ratios required in permitting may be more than the minimums shown in Table 5.2.3-17, subject to the evaluation of wetland functions and values.

Table 5.2.3-17 Summary of Wetland Mitigation Ratios

Regulation	Location of Effect	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, in-kind nor in-advance	1.5:1
		In-place, in-kind and in-advance	1:1
	<80% area	Not in-place, in-kind nor in-advance	2.5:1
		In-place, in-kind and in-advance	2:1

Sources: Wetland Conservation Act; USACE 2009.

PolyMet would ultimately need to satisfy both the federal and state mitigation requirements. The NorthMet Project Proposed Action is estimated to directly affect 912.5 acres. Depending on the location, type, and timing of compensatory mitigation, the minimum required amount of replacement wetlands for direct effects could potentially range from 912.5 acres up to 1,368.8 acres (i.e., 1:1 to 1.5:1 compensation ratios).

Indirect wetland mitigation would be determined by the USACE and the state during permitting. If the NorthMet Project Proposed Action were to be permitted, an indirect wetland effect monitoring plan would be implemented as part of the Section 404 permit conditions. In the event that the wetland monitoring identifies additional indirect effects, appropriate measures (i.e., adaptive management practices) would be implemented such as hydrologic controls or additional compensatory mitigation.

Wetland Mitigation Study Limits

USACE compensatory wetland mitigation is regulated by 33 CFR 332.3(n), which describes the use of financial assurances. The district engineer may determine that financial assurances are unnecessary for a compensatory mitigation project if alternate mechanisms are available to ensure a high level of confidence that the mitigation would be provided and maintained. In the state permitting process for WCA, *Minnesota Rules*, part 8420.0552 sets forth replacement standards and requires financial assurances to ensure successful wetland replacement. Additionally, the MDNR has the authority through the Permit to Mine process to require a performance bond as means to ensure compliance with *Minnesota Rules*, part 6130, which includes successful completion of reclamation and closure activities.

The NorthMet Project area lies in St. Louis County in the St. Louis River Watershed (#3) within the Lake Superior basin (wetland mitigation Bank Service Area #1). Locations for wetland mitigation projects were evaluated in the following priority order:

- on site;
- off site in the St. Louis River Watershed and adjacent watersheds tributary to Lake Superior;
- off site in watersheds adjacent to the St. Louis River Watershed; and
- 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) and state guidelines, the potential for creating wetlands on site was considered first. The Wetland Management Plan (PolyMet 2013h) has identified the following on-site mitigation. An estimated 101.8 acres of on-site wetland mitigation is planned in the temporary Category 2/3 Stockpile and the Overburden Storage and Laydown Area, and some haul roads and adjacent ditches as well as at the WWTF ponds and process water ponds may also provide minor acreages of land for wetland mitigation upon restoration. Establishment of on-site wetlands is expected to occur during reclamation. Of the 101.8 acres of planned on-site wetland mitigation, 72 acres of wetlands may be created at the temporary mine stockpile areas after removal of the Category 2/3 Stockpile and the Overburden Storage and Laydown Area. The remaining acres of wetland mitigation would be within the other above mentioned Project areas. Because it may not be feasible to construct wetlands on the entire footprint of these temporary areas, it has been assumed that only the area equivalent to the directly affected wetlands within the footprints would be viable for wetland mitigation. Design of wetland mitigation areas would be further evaluated in the detailed reclamation design and would include the preservation of upland buffer around the perimeter of the wetland mitigation areas. The establishment of the estimated 101.8 acres of on-site wetland mitigation is not included in the mitigation credits discussed below as part of the off-site mitigation. The on-site wetland mitigation may be considered by the agencies for wetland mitigation credits at some point in the future to compensate for potential indirect impacts, if the on-site restoration is successful.

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.

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 the NorthMet Project Proposed Action. Subsequently, a GIS analysis was performed to identify potential wetland mitigation sites within the defined study area. 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 (Barr 2008m). Other siting criteria used in the GIS analysis included potential wetland enhancement areas, potential wetland preservation areas, and potential wetland creation areas (Barr 2008m). 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 the following:

- 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 (MDNR 1980);
- major watersheds; and
- land cover (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 less than or equal to 1 percent slope;
- mapped areas as peat or lacustrine geomorphology;
- private or county tax-forfeit property;

- areas within 1.1 miles of a ditch; and ultimately
- areas meeting all of the above criteria with at least 100 contiguous acres.

The analysis was limited to sites with more than 100 acres of wetland mitigation potential due to the anticipated difficulties in planning numerous, small wetland mitigation projects, and the desire to identify opportunities that were feasible. In addition, the NorthMet Project Proposed Action 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 Proposed Action 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 has oversight regarding the administration of the Minnesota WCA. The Board of Water and Soil Resources provides guidance and interpretation of the WCA rules and has the most extensive experience with application of the rules. The Board of Water and Soil Resources' experience with wetland restoration on tribal lands found that impressing permanent conservation easements granted to the state was not possible to protect the restored wetlands.
- PolyMet had a signed agreement with St. Louis County near Floodwood to restore wetlands as mitigation (see discussion on Site 8362 below) for the NorthMet Project Proposed Action. 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. 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 (Barr 2008m).

Third, much of the study area was characterized by surface geology that is not indicative of large wetland systems prone to easy drainage. 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 terrains; 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.

Opportunities exist for accomplishing the preferred method of wetland compensation—restoration—within the St. Louis River Watershed and northeastern Minnesota in general. Tens of thousands of acres of peatlands are adversely affected by ditch systems. Specific to the St. Louis River Watershed, hundreds of acres of ditched, hydric soils in agricultural use exist in the central portion of the watershed. A determination by the USACE as to the practicality of wetland restoration within one or more of these sites has not been completed.

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. 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 CWA 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.

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 was located within the same watershed as the NorthMet Project area, had the greatest potential for wetland restoration with limited peripheral issues, and contained the potential to restore bog wetlands similar to those proposed for effect. Thus, Site 8362 was initially selected for further study and PolyMet signed an agreement with St. Louis County. Approximately 640 acres of the site are owned by the State of Minnesota with the remainder designated as tax-forfeit land. Further pursuit of wetland restoration activities at Site 8362 was halted for a number of reasons that rendered the site impracticable, including the following:

- The district court nullified PolyMet's agreement with St. Louis County in April 2007, thereby not allowing any further study of the site.
- There was a lack of local support, and there was, in fact, broad opposition from local residents.
- Extensive hydrologic monitoring and evaluation was required 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 was a demonstrable threat that could be eliminated (i.e., peat mining, tree-topping, or all-terrain vehicle 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 would have required ditch-abandonment proceedings in district court with public hearings that would have likely been opposed by local residents.
- The agreement with the county (if it were to be reinstated) would have 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. 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 affected 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 NorthMet Project area. These sites are located in watersheds neighboring those adjacent to the St. Louis River and outside the 1854 Ceded Territory. These two sites included the Aitkin mitigation site (Aitkin) and the Hinckley mitigation site (Hinckley).

One additional wetland restoration area has been further identified since the DEIS. The off-site wetland restoration projects, as defined in the Wetland Management Plan (PolyMet 2013h), that would provide required mitigation for the NorthMet Project Proposed Action wetland effects include Hinckley, Aitkin, and the Zim Sod (Zim) wetland mitigation sites. Mitigation credits assumed for calculations include 100 percent credit for restoration of drained/farmed wetlands and created ponds, 75 percent credit for creation of on-site wetlands, 50 percent credit for partially drained wetlands and ditches, 25 percent credit for upland buffer, and 12.5 percent credit for preservation. The final mitigation credits suitable for CWA, MPCA, and MDNR purposes that would be acceptable for offsetting effects due to the proposed NorthMet Project Proposed Action would be determined by the agencies during wetland permitting.

<u>Aitkin Site</u>

The Aitkin site is currently an active sod farm that has been drained by ditches and subsurface drain tiles. 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 (Barr 2008m).

The site has also been used for sod, wheat, soybeans, sunflowers, and wild rice production. The 1,070-acre site is located north of the city of Aitkin, Minnesota, in Aitkin County. The site is in the Elk-Nokasippi major watershed within bank service area #5, adjacent to bank service area #1 where the NorthMet Project area would be located.

The site is located outside of the NorthMet Project area watershed; therefore, the minimum replacement ratio that is likely to be allowed by the USACE is 1:1 for those wetlands that are replaced with the same wetland type and at least 1 year ahead of the effects (see Table 5.2.3-18). Under the Minnesota WCA, the replacement ratio that would likely be allowed is 1.5:1 for those wetlands that are replaced with the same wetland type, at least 1 year ahead of the effects, and out of the same watershed (see Table 5.2.3-19). The proposed wetland mitigation area includes 810 acres of wetland restoration and 123 acres of upland buffer preservation.

Restoration methods on the site are designed to restore the following wetland types: Type 2 fresh wet meadow, Type 2 sedge meadow, Type 3 shallow marsh, Type 4 deep marsh, Type 6 shrub-carr, Type 6 alder thicket, Type 7 hardwood swamp, Type 7 coniferous swamp, and Type 8 coniferous and open bog.

The site-specific mitigation design includes the following methods of restoration to receive wetland mitigation credits:

- restoration of effectively drained wetland on 810.2 acres for 100 percent mitigation credit or 810.2 credits; and
- restoration of native vegetation on 123.1 acres of effectively drained wetlands and filled ditches, for 30.8 credits based on the 25 percent credit calculation for upland buffer.

The vegetation and hydrology would likely be restored to the site over a 1- to 2-year construction period, followed by 5 to 20 years of management or more, if warranted. Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals. A permanent conservation easement would be prepared and recorded to protect the site within 1 year after initializing the restoration activities. The wetland restoration area would be monitored for 5 to 20 years beginning in the first full growing season after completing hydrologic restoration.

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 seed bank 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 Site</u>

The Hinckley site currently has about 375 acres under agricultural production and has been drained by ditches and sub-surface drain tiles. This 511-acre site is located southwest of the city of Hinckley, Minnesota at the intersection of Sod Road and Highway 107. The mitigation site is located in Pine County in the Snake River major watershed (#36) within bank service area #6, adjacent to bank service area #1 where the NorthMet Project area is located. 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 (Barr 2008m).

The site is located outside of the NorthMet Project area watershed; therefore, the minimum replacement ratio that is likely to be allowed by the USACE is 1:1 for those wetlands that are replaced with the same wetland type and at least 1 year ahead of the effects (see Table 5.2.3-18). Under the Minnesota WCA, the replacement ratio that would likely be allowed is 1.5:1 for those wetlands that are replaced with the same wetland type, at least 1 year ahead of the effects, and in the same watershed (see Table 5.2.3-19). A total of 313 acres of wetland restoration and 79 acres of upland buffer preservation are proposed.

Restoration methods on the site are designed to restore the following wetland types: Type 1 seasonally flooded, Type 2 fresh wet meadow, Type 2 sedge meadow, Type 3 shallow marsh, Type 6 shrub-carr, Type 6 alder thicket, Type 7 hardwood swamp, Type 7 coniferous swamp, and Type 8 coniferous bog.

The site-specific mitigation design includes the following methods of restoration to receive wetland mitigation credits:

- restoration of effectively drained wetlands on 306.1 acres for 100 percent mitigation credit or 306.1 credits;
- hydrologic restoration of 6.9 acres of partially drained wetlands to receive 50 percent credit or 3.5 credits; and
- restoration of native vegetation on 79.2 acres of effectively drained wetlands and filled ditches, for 19.8 credits based on the 25 percent credit calculation for upland buffer.

The vegetation and hydrology would likely be restored to the site over a 1- to 2-year construction period, followed by 5 to 20 years of management or more, if warranted. Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals. A permanent conservation easement would be prepared and recorded to protect the site within 1 year after initializing the restoration activities. The wetland restoration area would be monitored for 5 to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE that the wetland is sustainable.

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 seed bank 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.

Zim Site

The Zim site is currently an active sod farm that has been drained by ditches and sub-surface drain tiles. This site is located in two separate units (north and south) on approximately 569 acres of land located southwest of the city of Eveleth, Minnesota. The site is located in St. Louis County in the St. Louis River major watershed (#3), within the Lake Superior basin (bank service area #1). The overall objective of the Zim restoration plan is to restore a native wetland plant community.

The site is located within the NorthMet Project area watershed; therefore, the minimum replacement ratio that is likely to be allowed by the USACE is 1:1 for those wetlands that are replaced with either the same wetland type or at least 1 year ahead of the effects (see Table 5.2.3-18). Under the Minnesota WCA, the replacement ratio that would likely be allowed is 1:1 for those wetlands that are replaced with the same wetland type and in the same watershed (see Table 5.2.3-19).

Restoration methods on the site would be designed to restore a Type 8 coniferous bog community; however, developing a bog community is highly dependent on soil and groundwater parameters that are difficult to control. Therefore, a coniferous swamp community would be the contingent community if the soil and groundwater conditions are not adequate for bog regeneration. Coniferous bog or swamp is the target for the whole site; however, where trees do not successfully establish, the target community would be a sedge meadow or open bog.

The site-specific mitigation design includes the following methods of restoration to receive wetland mitigation credits:

- restoration of effectively drained wetlands on 401.5 acres for 100 percent mitigation credit or 401.5 credits;
- creation of 8.3 acres of excavated ponds for 100 percent mitigation credit or 8.3 credits;
- hydrologic restoration of 48.1 acres of partially drained wooded wetlands to receive 50 percent credit or 24.1 credits;
- restoration of natural surface grade and wetland conditions in 21.5 acres of ditches, which would be filled to receive 50 percent credit or 10.8 credits;
- restoration of native vegetation on 22.7 acres of effectively drained wetlands and filled ditches, each of which would remain drained due to open ditches that cannot be filled, for 5.7 credits based on the 25 percent credit calculation for upland buffer; and
- easement protection of 28.8 acres of native coniferous bog communities at 12.5 percent credit for a total of 3.6 credits for preservation.

The vegetation and hydrology would be restored to the site over a 1- to 2-year construction period, followed by 5 to 20 years of management or more, if warranted. Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals (Barr 2011e). A permanent conservation easement would be prepared and recorded to protect the site within 1 year after initializing the restoration activities. The wetland restoration area would be monitored for 10 to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE that the wetland is sustainable.

Table 5.2.3-18 Summary of Proposed Wetland Mitigation for Direct Effects Utilizing USACE Credits

	Zim Sod Wetland Mitigation (acres)	Aitkin Wetland Mitigation (acres)	Hinckley Wetland Mitigation (acres)	On-site Wetland Mitigation[1] (acres)	Total Wetland Mitigation (acres)	Total Wetland Mitigation Credits[2]	NorthMet Project Direct Wetland Effects (acres)	Wetland Mitigation Credits Utilized[3]	Potential Wetland Mitigation Credit Surplus
Off-site Restoration of Effectively Drained Wetlands									
Deepwater	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0
Type 1 Seasonally Flooded	0.0	0.0	20.1	---	20.1	20.1	0.0	0.0	20.1
Type 2 Fresh (Wet) Meadow	0.0	21.8	14.3	---	36.1	36.1	15.8	15.8	20.3
Type 2 Sedge Meadow	0.0	47.1	39.1	---	86.2	86.2	23.8	73.6	12.6
Type 3 Shallow Marsh	0.0	86.9	1.4	---	88.3	88.3	76.7	76.7	11.6
Type 4 Deep Marsh	0.0	33.6	0.0	---	33.6	33.6	73.5	33.6	0.0
Type 5 Shallow, Open Water	8.3	0.0	0.0	---	8.3	8.3	0.0	0.0	8.3
Type 6 Shrub-Carr	0.0	83.9	87.1	---	171.0	171.0	3.9	3.9	167.1
Type 6 Alder Thicket	0.0	82.8	27.4	---	110.2	110.2	106.9	106.9	3.3
Type 7 Hardwood Swamp	0.0	52.6	7.1	---	59.7	59.7	12.5	12.5	47.2
Type 7 Coniferous Swamp	0.0	89.1	8.4	---	97.5	97.5	82.6	82.6	14.9
Type 8 Open Bog	0.0	74.2	0.0	---	74.2	74.2	7.6	7.6	66.6
Type 8 Coniferous Bog	401.5	238.2	101.2	---	740.9	740.9	470.7	470.7	270.2
Off-site Restoration of Partially Drained Wetlands and Ditches									
Type 2 Sedge Meadow	0.0	0.0	0.8	---	0.8	0.4	0.0	0.0	0.4
Type 6 Shrub-Carr	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0
Type 7 Coniferous Swamp	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0
Type 7 Hardwood Swamp	0.0	0.0	6.1	---	6.1	3.1	0.0	0.0	3.1
Type 8 Coniferous Bog	69.6	0.0	0.0	---	69.6	34.8	34.8	34.8	0.0
Off-site Site Preservation									
Type 8 Coniferous Bog	28.8	0.0	0.0	---	28.8	3.6	3.6	3.6	0.0
Off-site Upland Buffer	22.7	123.1	79.2	---	225.0	56.3	0.0	0.0	56.3
On-site Wetland	---	---	---	101.8	101.8	76.3	0.0	0.0	76.3
On-site Upland Buffer	---	---	---	0.0	0.0	0.0	0.0	0.0	0.0
Upland Total	**22.7**	**123.1**	**79.2**	**0.0**	**225.0**	**56.3**	0.0	0.0	**56.3**
Wetland Total	**508.2**	**810.2**	**313.0**	**101.8**	**1,733.2**	**1,644.3**	**912.5**	**922.4**	**721.9**
Total	**530.9**	**933.3**	**392.2**	**101.8**	**1,958.2**	**1,700.5**	**912.5**	**922.4**	**778.1**

Source: PolyMet 2013h.

[1] No wetland types have been identified.

[2] Credit assumed at 100 percent for restoration of effectively drained/farmed wetlands and created pond, 75 percent for on-site wetlands, 50-75 percent for partially drained wetlands and ditches, 25 percent for upland buffer, and 12.5 percent for preservation.
[3] Assumes 1:1 replacement since all effects compensated in-kind and ahead of time (off site) and in-kind and in-place (on site).

Table 5.2.3-19 Summary of Proposed Wetland Mitigation for Direct Effects Utilizing Minnesota Wetland Conservation Act Credits

	Zim Sod Wetland Mitigation (acres)	Aitkin Wetland Mitigation (acres)	Hinckley Wetland Mitigation (acres)	On-site Wetland Mitigation[1] (acres)	Total Wetland Mitigation (acres)	Total Wetland Mitigation Credits[2]	NorthMet Project Direct Wetland Effects (acres)	Wetland Mitigation Credits Utilized: Zim Sod[3]	Wetland Mitigation Credits Utilized: Aitkin/ Hinckley[4]	Wetland Mitigation Credits Utilized: On-site[5]	Potential Wetland Mitigation Credit Surplus[6]
Off-site Restoration of Effectively Drained Wetlands											
Deepwater	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0	---	0.0
Type 1 Seasonally Flooded	0.0	0.0	20.1	---	20.1	20.1	0.0	0.0	0.0	---	20.1
Type 2 Fresh (Wet) Meadow	0.0	21.8	14.3	---	36.1	36.1	15.8	0.0	23.7	---	12.4
Type 2 Sedge Meadow[3]	0.0	47.1	39.1	---	86.2	86.2	23.8	0.0	62.4	---	23.8
Type 3 Shallow Marsh	0.0	86.9	1.4	---	88.3	88.3	76.7	0.0	88.3	---	0.0
Type 4 Deep Marsh	0.0	33.6	0.0	---	33.6	33.6	73.5	0.0	33.6	---	0.0
Type 5 Shallow, Open Water	8.3	0.0	0.0	---	8.3	8.3	0.0	0.0	0.0	---	8.3
Type 6 Shrub-Carr	0.0	83.9	87.1	---	171.0	171.0	3.9	0.0	132.6	---	38.4
Type 6 Alder Thicket	0.0	82.8	27.4	---	110.2	110.2	106.9	0.0	110.2	---	0.0
Type 7 Hardwood Swamp	0.0	52.6	7.1	---	59.7	59.7	12.5	0.0	18.7	---	41.0
Type 7 Coniferous Swamp	0.0	89.1	8.4	---	97.5	97.5	82.6	0.0	97.5	---	0.0
Type 8 Open Bog	0.0	74.2	0.0	---	74.2	74.2	7.6	0.0	11.5	---	62.7
Type 8 Coniferous Bog	401.5	238.2	101.2	---	740.9	740.9	470.7	401.5	130.3	---	209.1
Off-site Restoration of Partially Drained Wetlands and Ditches											
Type 2 Sedge Meadow	0.0	0.0	0.8	---	0.8	0.4	0.0	0.0	0.0	---	0.4

	Zim Sod Wetland Mitigation (acres)	Aitkin Wetland Mitigation (acres)	Hinckley Wetland Mitigation (acres)	On-site Wetland Mitigation[1] (acres)	Total Wetland Mitigation (acres)	Total Wetland Mitigation Credits[2]	NorthMet Project Direct Wetland Effects (acres)	Wetland Mitigation Credits Utilized			Potential Wetland Mitigation Credit Surplus[6]
								Zim Sod[3]	Aitkin/ Hinckley[4]	On-site[5]	
Type 6 Shrub-Carr	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0	---	0.0
Type 7 Coniferous Swamp	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0	---	0.0
Type 7 Hardwood Swamp	0.0	0.0	6.1	---	6.1	3.1	0.0	0.0	0.0	---	3.1
Type 8 Coniferous Bog	69.6	0.0	0.0	---	69.6	34.8	34.8	34.8	0.0	---	0.0
Off-site Site Preservation											
Type 7 Coniferous Swamp	28.8	0.0	0.0	---	28.8	3.6	3.6	3.6	0.0	---	0.0
Off-site Upland Buffer	22.7	123.1	79.2	---	225.0	56.3	0.0	0.0	0.0	---	56.3
On-site Wetland	---	---	---	101.8	101.8	76.3	0.0	---	---	0.0	76.3
On-site Upland Buffer	---	---	---	0.0	0.0	0.0	0.0	---	---	0.0	0.0
Upland Total	**22.7**	**123.1**	**79.2**	**0.0**	**225.0**	**56.3**	0.0	**0.0**	**0.0**	**0.0**	**56.3**
Wetland Total	**508.2**	**810.2**	**313.0**	**101.8**	**1,733.2**	**1,644.3**	**912.5**	**439.9**	**708.8**	**0.0**	**495.5**
Total	**530.9**	**933.3**	**392.2**	**101.8**	**1,958.2**	**1,700.5**	**912.5**	**439.9**	**708.8**	**0.0**	**551.8**

Source: PolyMet 2013h.

1 No wetland types defined.
2 Credit assumed at 100 percent for restoration of effectively drained/farmed wetlands and created pond, 75 percent for creation of on-site wetlands, 50-75 percent for partially drained wetlands and ditches, 25 percent for upland buffer, and 12.5 percent for preservation.
3 Assumes 1:1 replacement since all effects compensated in-kind, ahead of time, and in the same watershed.
4 Assumes 1.5:1 replacement since all effects compensated in-kind, ahead of time, but outside of the same watershed.
5 Assumes 1:1 replacement since all effects compensated in-kind and in-place.
6 For in-kind mitigation, assumes the Zim Sod site wetland mitigation credits are utilized first, then the Aitkin and Hinckley credits. The 106.9 acres of alder thicket effects are mitigated by 110.2 credits of Type 6 alder thicket and 50.2 credits of Type 6 shrub-carr. The 73.5 acres of deep marsh effects are mitigated by 33.6 credits of Type 4 deep marsh and 76.7 credits of Type 6 shrub-carr. The 82.6 acres of coniferous swamp effects are mitigated by 97.5 credits of Type 7 coniferous swamp and 26.4 credits of Type 8 coniferous bog.

5.2.3.3.3 Mitigation Summary

Compensatory mitigation is required for the 912.5 acres of wetlands that would be directly affected. The overall wetland mitigation strategy for the NorthMet Project Proposed Action is to replace unavoidable wetland effects in-kind where possible and in advance of effects when feasible. A combination of off-site and on-site wetland mitigation projects would be implemented to fulfill the requirements for compensatory mitigation. PolyMet's current mitigation proposal includes:

- On-site mitigation totaling 101.8 acres of wetland creation.
- Off-site mitigation including:
  - Aitkin Site – 810.2 acres of wetland restoration and 123.1 acres of upland buffer;
  - Hinckley Site – 313.0 acres of wetland restoration and 79.2 acres of upland buffer; and
  - Zim Site – 508.2 acres of wetland restoration and 22.7 acres of upland buffer.

Off-site wetland compensation of 1,631.4 acres could provide 1,568.0 wetland mitigation credits. In addition, a total of 225.0 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 would be at a 4:1 ratio, resulting in an additional 56.3 credits. The total off-site mitigation could provide 1,624.3 wetland mitigation credits. Tables 5.2.3-18 and 5.2.3-19 provide a summary of wetland mitigation. Compensatory mitigation ratios determined in permitting may vary from these assumptions, which would result in a different percentage of mitigated effects.

Finally, establishment of approximately 101.8 acres of wetland would likely occur during reclamation of the Mine Site; this establishment is not included in the mitigation credits discussed above.

The overall wetland mitigation strategy for the NorthMet Project Proposed Action is to replace unavoidable wetland effects in-kind where possible and in advance of effects when feasible. Due to both on-site and off-site limitations and technical feasibility, it was not found to be practicable to replace all affected wetland types with an equivalent area of in-kind wetlands. For instance, for the overall NorthMet Project area wetland effects, the deep marsh acreage directly affected could potentially be 73.5 acres and the total deep marsh wetlands compensated for would be 33.6 acres (see Table 5.2.3-18). Most other wetland community types proposed to be directly affected would be replaced with comparable wetland communities.

Further, in accordance with the federal Mitigation Rule, USACE policy, and overall requirements of the CWA, the primary focus of compensatory mitigation is to replace lost wetland functions within the same watershed as the impact site—in this case, the St. Louis River Watershed/Great Lakes Basin. Approximately 69 percent of the credits proposed would be located outside of this watershed. Whether this degree of permanent wetland losses and associated functions within the St. Louis River Watershed/Great Lakes Basin is acceptable remains to be determined by the USACE. This is particularly critical in that 8-digit Hydrologic Unit Code watersheds adjacent to the Great Lakes—including the St. Louis River Watershed—have been identified as coastal watersheds for purposes of the federal Mitigation Rule. The Rule places additional emphasis on replacing coastal wetland losses within a coastal watershed.

Should the USACE determine that a greater percentage of the compensation be accomplished within the St. Louis River Watershed/Great Lakes Basin, the applicant may be directed to re-evaluate compensation opportunities within that watershed.

The USACE requires a detailed compensatory mitigation plan for anticipated wetland effects that would occur during the first 5 years of the NorthMet Project Proposed Action. A detailed mitigation plan must be submitted for each subsequent 5-year increment of wetland effects 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 effects, while other wetlands would be restored after the effects.

The change in wetland hydrology from groundwater drawdown at the Mine Site was assessed by two different methodologies; therefore, total indirect wetland effects were provided based on both approaches. The NorthMet Project Proposed Action could indirectly affect up to either approximately 7,228 acres of wetlands located within and around the NorthMet Project area based on the method of wetlands crossing analog impact zones, or 6,313.1 acres of wetlands located within and around the NorthMet Project area based on the method of wetlands within analog impact zones. Mitigation for indirectly affected acres would be through monitoring, discussed below. In order to determine if actions of the NorthMet Project Proposed Action cause future wetland effects, wetlands would be monitored as required by the Section 401 WQC, CWA Section 404 permit, and WCA approval. These could require additional compensation if determined necessary based on monitoring results. The monitoring plan would be based on those wetlands that have a high likelihood of indirect effects as a result of groundwater drawdown. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified during the annual reporting.

5.2.3.3.4 Monitoring

Wetland monitoring would be performed to demonstrate performance of wetland mitigation and indirect wetland effects at the Mine Site and Plant Site. Monitoring of the restored areas would assess whether or not the restored wetlands are in conformance with performance standards and would determine whether continued monitoring would be required.

The wetland restoration area monitoring would begin during the first full growing season after completing hydrologic restoration. In addition, the compensation sites would be monitored within the general area of the restoration site, in areas with relatively natural hydrologic conditions. A monitoring plan would be submitted to the appropriate state and federal agencies for review and approval that would include proposed locations of reference wetlands prior to implementing the monitoring program.

Vegetative monitoring would entail conducting a detailed vegetation survey once per year (typically July to August) in each wetland mitigation community, as well as the reference wetland communities, to evaluate the success of the restoration during the appropriate monitoring period for each community type.

Hydrologic monitoring would involve the installation and periodic monitoring of shallow recording wells. Continuous recording wells would be utilized to the extent feasible and would be placed throughout the sites sufficient to characterize hydrology. Water elevations would be recorded at least once per week from May through mid-July and monthly thereafter until the end of the growing season.

Off-site Wetland Monitoring

Hydrology monitoring wells would be removed from Zim at the end of year 5, if the hydrology performance standards are met (Barr 2011e). Hydrologic parameters for Hinckley and Aitkin would be evaluated in the mitigation areas more intensively during the first 2 years and then would be performed at a level appropriate to the hydrologic characteristics of each area thereafter (Barr 2008m).

Monitoring reports would be prepared and submitted for Zim in years 1, 3, 5, 10, and 20, as necessary. The monitoring report completed after the tenth growing season would assess whether or not the restoration is sufficiently complete and whether or not additional monitoring and reporting are needed. A monitoring report for Hinckley and Aitkin, respectively, would be prepared annually during the 5-year monitoring period for all except the shrub, forested, and bog communities. Annual monitoring reports would be prepared following growing seasons 1, 2, 3, 5, and 8 following restoration for the shrub communities and following growing seasons 1, 2, 3, 5, 10, and 20 for the forested and bog communities. Reports would describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, discuss management activities and corrective actions conducted during the previous year, and discuss activities planned for the following year. The reports would be submitted to the USACE and MDNR by December 31 of each year.

Monitoring of Mine Site and Plant Site Wetlands for Potential Indirect Effects

Monitoring would assess whether or not the wetlands have been affected by the potential indirect effects, as part of the USACE Section 404 permit requirements. Pre-project wetland hydrology monitoring of the wells within the Mine Site started in 2005 and in 2010 at the Plant Site, and would continue throughout the NorthMet Project Proposed Action in accordance with the planned study (PolyMet 2013b). The objectives of the Mine Site and Plant Site wetland hydrology monitoring studies include the following:

1. Gain a better understanding of the wetland hydrology at the Mine Site and Plant Site (i.e., defining whether specific wetlands are recharging the surficial deposits aquifer or are discharging to surface waters).
2. Collect baseline hydrology data at the Mine Site and Plant Site that could be used to assess the effect of the NorthMet Project Proposed Action on wetland hydrology.
3. Review the data collected at the Mine Site in the hydrogeologic study along with the wetland hydrology data to determine whether specific wetlands within the Mine Site area have perched water tables or are in direct hydrologic connection with the surficial deposits aquifer.
4. Determine the potential for indirect wetland effects at the Mine Site and Plant Site resulting from the NorthMet Project Proposed Action.

Shallow monitoring wells were installed at eight locations around the Plant Site in 2010. One of the eight wells was installed in a reference wetland located north of the Plant Site that would not be affected by the NorthMet Project Proposed Action. Two monitoring wells were placed west of the Plant Site along Unnamed Creek; two wells were placed north of the Plant Site, adjacent to a large deep marsh wetland complex; and three wells were placed along the flowpath of Trimble Creek. The monitoring wells were typically placed to a depth of 2 to 5 feet bgs.

Monitoring of reference wetlands documents the natural hydrologic fluctuations in wetlands that would not be affected by the NorthMet Project Proposed Action and would facilitate interpretation of the NorthMet Project Proposed Action data in relation to climatic fluctuations.

Wetland hydrology monitoring would be conducted during operation of the NorthMet Project Proposed Action to document indirect wetland effects. Prior to the start of the NorthMet Project Proposed Action, monitoring would be developed based on permit conditions, which would describe the purpose, methods, and criteria to be implemented to document indirect wetland effects. Six additional wetland monitoring locations at the Mine Site and two additional locations at the Plant Site are proposed as part of permit conditions. The six additional wells at the Mine Site would be located within wetlands that include alder thicket, shallow marsh, coniferous swamp, and coniferous bog. One of six additional wetland monitoring wells would be located within a reference wetland (shrub swamp), located to the southwest of the Mine Site. The two additional wells at the Plant Site would be located within in shallow marsh and shrub swamp wetland north of the Plant Site.

5.2.3.3.5 Reporting

Reports would be compiled to document activities at the off- and on-site wetland mitigation projects, which would be implemented to fulfill the requirements for compensatory mitigation.

Off-site Monitoring Reports for Wetland Restoration

Reports have been prepared to document the activities that would be conducted at the off-site wetland mitigation sites, which include information regarding existing conditions at the site, construction activities, management activities, wetland restoration goals, performance standards, schedules, and monitoring plans (Barr 2008m; Barr 2011e). These plans were developed to comply with WCA rules (*Minnesota Rules*, chapter 8420), Section 404 of the CWA as administered by the USACE, and *Minnesota Rules*, part 7050.0186 (wetland mitigation) as administered by the MPCA.

A project-specific wetland mitigation plan for Zim was prepared that describes the compensatory wetland mitigation that would be used to replace unavoidable wetland effects associated with the NorthMet Project Proposed Action. The preliminary wetland mitigation plan was submitted to the USACE in November 2011 (PolyMet 2013b).

A wetland restoration plan for Hinckley and Aitkin was prepared describing the compensatory wetland mitigation that would be used to replace unavoidable wetland effects associated with the NorthMet Project Proposed Action. Preliminary wetland restoration plans were submitted to the USACE and MDNR Division of Lands and Minerals in August 2007 (PolyMet 2013b).

Reporting on Mine Site and Plant Site Wetland Hydrology for Potential Indirect Effects

Pre-project wetland hydrology monitoring reports, to meet reporting requirements, have been submitted to the USACE and the MDNR that document 5 years of pre-project planning at the Mine Site (2005 to 2009). Pre-project wetland hydrology monitoring has been conducted at the Mine for years 6 and 7 (2010 and 2011); however, reports have not yet been submitted. Pre-project wetland hydrology monitoring at the Plant Site has been conducted for years 1 and 2 (2010 and 2011); however, reports have not yet been submitted. Project wetland hydrology monitoring reports would be submitted in accordance with permit conditions.

5.2.3.4 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and, therefore, the NorthMet Project Proposed Action would have no direct and indirect wetland effects. However, forest harvesting would continue to occur in portions of the federal lands, including the Mine Site. Direct and indirect effects of the NorthMet Project No Action Alternative on wetlands are not expected, as the federal lands would continue to be managed as they currently are. The use of privately owned land could affect wetlands under the NorthMet Project No Action Alternative; however, any potential wetland effects would require state and/or federal permits. Existing disturbed wetlands associated with the Tailing Basin seepage areas may recover more quickly to a more natural hydrology and wetland system under the NorthMet Project No Action Alternative than under the NorthMet Project Proposed Action.

5.2.4 Vegetation

This section describes the environmental consequences of the NorthMet Project Proposed Action to vegetation, which include direct effects on land cover types, native plant community types, MBS Sites of Biodiversity Significance, and rare or sensitive plant species, as well as effects from existing or introduced invasive non-native species.

Summary

The NorthMet Project Proposed Action would disturb 1,718.6 acres of the Mine Site and have the greatest effect on upland conifer forest land cover types. However, lowland conifer forest types would be affected, as well, and are higher quality than the upland conifer forests (Table 4.2.4-1). Approximately 2,178 acres of the Plant Site would be disturbed by the NorthMet Project Proposed Action, with most effects occurring in already disturbed areas and tailings ponds. All land within the Transportation and Utility Corridor would be affected (120.2 acres), the majority of which is already disturbed.

The NorthMet Project Proposed Action would affect 1,741.1 acres of MBS Sites of High Biodiversity Significance, 698.2 acres of "imperiled" or "vulnerable" native plant communities, and 2 acres of "widespread and secure" native plant communities.

Reclamation activities could introduce invasive non-native species to the high quality area around the Mine Site, depending on which species are chosen, but preference would be given to the establishment of native plant communities. The Plant Site itself is already heavily disturbed, but the area around the Plant Site could be affected by the introduction of additional invasive non-native species.

There are no federally listed plant species at the NorthMet Project area. There are 11 state-listed plant species, all at the Mine Site; 9 species would be directly affected and 2 would be indirectly affected by the NorthMet Project Proposed Action.

5.2.4.1 Methodology and Evaluation Criteria

This section compares the types of data presented in Section 4.2.4 for the NorthMet Project area. Specifically, GIS data were obtained from the MDNR regarding GAP land cover types, native plant communities, MBS Sites of Biodiversity Significance, and listed ETSC plant species within the NHIS. Data were obtained from the USFS regarding MIH types, forest stand age classes, RFSS, invasive non-native species, and landscape ecosystems. Separate NorthMet Project area-specific listed species survey reports were also utilized to supplement MDNR NHIS data and estimate effects on populations.

GIS analysis was used to calculate effects on the data layers mentioned above. The effects were calculated for habitat types, classifications, and species where they overlap the NorthMet Project area footprints.

Direct effects to natural features (e.g., vegetative cover types, plant communities, sites of biodiversity significance, and rare species) occur through clearing, filling, and other construction activities. A direct effect to an ETSC plant species occurs when the action results in the removal or loss (i.e., taking) of an individual plant or entire plant population. Direct effects are those that are a result of the NorthMet Project Proposed Action, that are immediate, and that often last for years.

An indirect effect occurs when a cover type, plant community, Site of Biodiversity Significance, or rare species experiences a change in vegetative composition. Indirect effects can occur over time or after the action is completed and can occur on- or off-site. Indirect effects on vegetation 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), loss of pollinators or loss of fungal associates in the rooting zone, erosion and sedimentation, and invasion of non-native species. Indirect effects were estimated by comparing the proximity of the NorthMet Project area infrastructure footprints to existing natural features (e.g., habitat types, plant species present).

5.2.4.2 NorthMet Project Proposed Action

This section describes the effects of NorthMet Project Proposed Action construction, operation, and closure on vegetation cover types and plant species. Potential effects from invasive non-native species are discussed separately.

5.2.4.2.1 Mine Site

<u>Effects on Cover Types</u>

Habitat Types

Construction and operation of the NorthMet Project Proposed Action at the Mine Site would directly affect 1,718.6 acres (57 percent of the Mine Site) of land with various MDNR GAP land cover designations as a result of excavating the mine pits and creating overburden and waste rock stockpiles and associated internal haul roads and drainage ditches. As shown in Table 5.2.4-1, these effects would include 62 percent (741.9 acres) of the upland conifer forest at the Mine Site. Other high-acreage directly-affected cover types include lowland coniferous forest (437.2 acres) and upland deciduous forest (354.7 acres). Approximately 1,295.9 acres, or about 43 percent of the Mine Site, would not be disturbed. 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 MDNR NHIS condition ranking system (Table 4.2.4-1) (MDNR 2013a). Most of the forested wetlands affected by the NorthMet Project Proposed Action are in fair to excellent condition (Table 4.2.4-1); the wetland field assessment also indicated a high level of wetland quality. Section 5.2.3 provides a more detailed discussion of wetland effects.

Table 5.2.4-1 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
Upland coniferous forest	741.9	453.6	1,195.5	62
Lowland coniferous forest	437.2	344.0	781.2	56
Upland deciduous forest	354.7	293.3	648.0	55
Shrubland	133.0	108.7	241.7	55
Disturbed	44.0	84.0	128.0	34
Aquatic environments	6.0	6.7	12.7	47
Upland conifer-deciduous mixed forest	1.5	0.9	2.4	63
Cropland/grassland	0.2	4.7	4.9	4
Lowland deciduous forest	0.0	0.1	0.1	0
Total [2]	1,718.6	1,295.9	3,014.5	57

Source: MDNR 2006b.

[1] Areas of cover types not directly affected by mine pits, stockpiles, roads, or other infrastructure.
[2] Total acres may be more or less than presented due to rounding.

Minnesota Biological Survey

Approximately 353.6 acres of the One Hundred Mile Swamp MBS Site of High Biodiversity Significance and 1,364.9 acres of the Upper Partridge River MBS Site of High Biodiversity Significance would be affected by the NorthMet Project Proposed Action. The portions of these two MBS sites that are within the Mine Site area represent a small portion of the mapped Sites of High Biodiversity Significance in St. Louis County (2 percent) and the State of Minnesota (less than 1 percent). Habitat effects associated with the NorthMet Project Proposed Action would not result in a large percentage decline in statewide areas ranked as high by the MBS (MDNR 2008a).

Approximately 698.2 acres of the “imperiled-vulnerable” or “vulnerable” native plant communities—the black spruce-Jack pine woodlands (FDn32c; 495.5 acres) and rich black spruce swamp (FPn62a; 202.7 acres), respectively—would also be affected. Approximately 92.6 acres of the “apparently secure” native plant communities (i.e., black spruce bog: treed subtype [APn80a1; 77.7 acres] and poor tamarack-black spruce swamp [APn81b; 14.9 acres]) would be affected. Approximately 178.9 acres of “widespread and secure” native plant communities would also be affected, including alder (maple-loosestrife) swamp (FPn73a; 42.5 acres), aspen-birch forest: balsam fir subtype (FDn43b1; 101.1 acres), and poor black spruce swamp (APn81a; 35.3 acres).

Culturally Important Plants

Effects on wild rice as a result of the NorthMet Project Proposed Action are expected to be minimal. The 10-mg/L sulfate standard for wild rice would be met for the Embarrass River, since the containment and seepage collection system would capture seepage presently going to the Embarrass River tributaries. The Partridge River will, at certain times of the year, exceed the 10-mg/L sulfate standard, mostly during winter low-flow conditions. During the remainder of the year, in high-flow conditions, the NorthMet Project Proposed Action has a low probability of increasing sulfate contributions. Effects, as well as water quality standards, are discussed more thoroughly in Section 5.2.2.

While a distinct list of plant species important to the Bands is not available, Sections 4.2.9 and 5.2.9 discuss more broadly the effects to the ecological subsections, large landscapes, and connected ecosystems.

Indirect Effects

In addition to the direct effects mentioned above, indirect effects on vegetative cover types at the Mine Site are expected to be associated with dust from road traffic and mining operations and with changes in hydrology. Dust on leaves can affect the rates of photosynthesis and respiration, which both influence plant growth. If sulfide-containing dust is deposited on leaves, it could react with oxygen in the air and water from precipitation to create sulfates over a period of weeks to months. This could result in acidic damage to the plants themselves or, more likely, the residual build-up in the soil could inhibit growth by slowly acidifying the soil conditions. Such effects of fugitive dust, if any, are likely to occur south of the East Pit and West Pit 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 by temporarily establishing vegetation and water spraying during dry periods (consistent with *Minnesota Rules*, part 6132.2800). Section 5.2.7.4.1 further discusses fugitive dust control and mitigation measures. These measures, which are standard practice for existing taconite mines on the Mesabi Iron Range, should be adequate to minimize potential indirect effects from fugitive dust.

Reclamation

Reclamation activities help to offset a portion of the effects of a project. Reclamation and revegetation at the Mine Site would promote cover development and initiate vegetative succession on stockpiles, the combined East Central Pit, and Mine Site infrastructure footprints. Fertilizer would be applied at rates recommended for each group of species planted, and would be worked into the soil to a depth of 8 inches on the level and 4 inches on all slopes (PolyMet 2012n). On areas to be mulched after seeding, no more seed would be sown than could be mulched the same day. Seed would be sown via mechanical Truax native seed drills or hydrospreading at specified rates of application, unless inaccessible or wet areas dictate the use of hand-operated spreaders. Seedbeds would be firmed using cultipackers, or seeds would be hand-raked into the soil, before mulching. Six different types of mulch could be applied, depending on the situation. As nutrients and organic matter are returned to the soil, the conditions on the reclaimed areas would become more suitable for migration of nearby native herbaceous and woody species.

The Category 1 Stockpile would be incrementally and progressively reclaimed throughout the life of the mine, starting in year 14, to minimize erosion of the outer slopes, promote post-closure land use, and minimize the need for active site care and maintenance during the post-closure period. Prior to construction of the cover system, the stockpile surfaces would be graded for long-term stability, to promote vegetation growth and erosion control, and to develop a surface drainage network over the stockpile (PolyMet 2012s). After grading, an engineered geomembrane system would be constructed. The geomembrane system would consist of, from top to bottom: 18 inches of rooting zone soil consisting of on-site unsaturated overburden mixed with peat, as needed, to provide organic matter; 12 inches of granular drainage material with drain pipes to facilitate lateral drainage of infiltrating precipitation and snowmelt off the stockpile cover; a 40 mil geomembrane barrier layer; and a 6-inch soil bedding layer below the geomembrane (PolyMet 2013c). The stockpile would then be locally contoured to provide some topographic variety to the surface. Finally, the stockpile would be seeded with a certain selection of grasses/forbs at the top and bench flats and a potentially different group of species for the slopes, depending on the availability and suitability of the species (PolyMet 2012n). The three groups of species designated for the top and benches would include a group of native species, a group of non-native species, and a mixed group. The species mix for the stockpile slopes would contain the same native species as the stockpile bench and flats, and a slightly modified group of non-native species. The cover would store precipitation within the loose layer during the period when vegetation is dormant. The trapped water would then be removed from the cover system by transpiration of the plants during the growing season and evaporation. Vegetation would also aid in stabilizing the cover from wind and rain erosion (PolyMet 2012s).

Both the Category 2/3 Stockpile and the Category 4 Stockpile would be temporary and would be removed at closure. Temporary stockpile reclamation would begin during operations. The material in these stockpiles would be relocated to the East Pit starting in year 11 (PolyMet 2013c). After removal of the material, the footprint of the Category 2/3 Stockpile and portions of the Category 4 Stockpile that do not become the Central Pit would be reclaimed by subsequent seeding and planting of grass and forb species similar to those planted for the Category 1 Stockpile top and benches (PolyMet 2012n). Depressions in both temporary stockpile footprints with sufficient hydrology and soil conditions would be seeded with a different group of native grasses (e.g., fringed brome, bluejoint, Virginia wild rye, tall manna grass, fowl bluegrass, tussock sedge, pointed broom sedge, dark green bulrush, and woolgrass) and forbs (e.g., Canada anemone, marsh milkweed, flat-topped aster, common boneset, grass-leaved goldenrod, spotted Joe Pye weed, blue monkey flower, giant goldenrod, and Eastern panicled aster) suitable for wet soils. The West Pit would become open water, while the combined East Central Pit would be partially filled with material from the Category 2/3 Stockpile and Category 4 Stockpile to support wetland vegetation with species discussed above for the removed stockpile depressions (Table 5.2.4-2). The pit wall overburden slopes would be planted with the same mix mentioned for stockpile slopes above (PolyMet 2012n). The acres reclaimed (Table 5.2.4-2) do not equal the acres disturbed as some haul roads and buildings would remain after cessation of operations.

Following demolition of Mine Site buildings and parking areas, suitable overburden would be placed over the footprint, to a depth of 2 ft, and revegetated (PolyMet 2013a). Mine Site roads deemed unnecessary for future access by the MDNR would be scarified and revegetated, as well. Disturbed areas, building sites, and reclaimed roads would all be seeded with a similar mix of grass and forb species as that planted on the Category 1 Stockpile top and benches (PolyMet 2012n).

Table 5.2.4-2 Proposed Vegetation Types and Acreages for Reclaimed Stockpiles and Pits at the Mine Site

Type	Proposed Reclamation Vegetation	Acres
Category 1 Stockpile	Grassland/herbaceous	526
Category 2/3 Stockpile (Removed)	Wetland; Grassland/herbaceous	180
Category 4 Stockpile (Removed)	Wetland; Grassland/herbaceous	57
Lean Ore Surge Pile (Removed)	Wetland; Grassland/herbaceous	31
Overburden Storage and Laydown Area (Removed)	Wetland; Grassland/herbaceous	41
East and Central Pits	Wetland	207
West Pit	Open pit lake	321
Roads, Parking Areas, Buildings	Grassland/herbaceous	88
Total		1,451

Source: PolyMet 2012n; PolyMet 2013c; PolyMet 2012s; Kearney, Barr Engineering, Pers. Comm., February 6, 2013.

Effects of Invasive Non-native Plants

Disturbances associated with the construction of the Mine Site would result in exposed soil surfaces that would have the potential for colonization by invasive species. PolyMet proposes to temporarily vegetate and stabilize disturbed areas during operation and permanently reclaim during closure by spreading seeds. Species proposed for revegetation on most disturbed areas and the Category 1 Stockpile top and benches include native and non-native species. There are native grass species (e.g., fringed brome, switchgrass, Canada wild rye, bluejoint, poverty oatgrass, slender wheatgrass, fowl bluegrass, and false melic) and native forb species (e.g., common yarrow, pearly everlasting, flat-topped aster, tall cinquefoil, large-leaved aster, stiff goldenrod, smooth wild rose, black-eyed susan, gray goldenrod, upland white goldenrod, Lindley's aster, smooth aster, and American vetch). Preference would be given to establishing native plant communities, and the introduction of invasive plant species would be avoided to the extent that such a practice would not interfere with the timely and effective accomplishment of the primary objectives for establishing vegetation (PolyMet 2012n). These objectives include rapidly establishing a self-sustaining plant community, controlling air emissions, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance.

Non-native species that could be planted include: oats, winter wheat, alfalfa, timothy, redtop, alsike clover, white clover, Canada bluegrass, intermediate wheatgrass, cicer milkvetch, birdsfoot trefoil, perennial ryegrass, smooth brome grass, meadow brome, 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 soil stability. The legume species listed would also fix atmospheric nitrogen into the soil to help re-establish soil nutrients. All of these species, however, are non-native and some of the proposed species are considered invasive (e.g., birdsfoot trefoil, redtop, smooth brome grass, Canada bluegrass).

The proposed Type 1 mulch (hay, straw, and agricultural grass/legume cuttings) would be relatively free of seed-bearing stalks or propagules of noxious weed species, as defined by the rules and regulations of the Minnesota Department of Agriculture (PolyMet 2012n).

The introduction of invasive non-native species would be more detrimental to the relatively high-quality vegetation communities at the Mine Site than to those at the Plant Site, which is already heavily disturbed. Using invasive non-native species would result in decreased diversity of plant species and habitats available to wildlife species. Several ETSC plant species at the Mine Site may be susceptible to increased competition from invasive non-native species. There are already a few occurrences of yellow sweetclover and bladder campion at the Mine Site, which may invade future disturbed areas.

Effects on Threatened and Endangered Plant Species

The MDNR NHIS and separate rare species surveys were utilized to map known ETSC species locations using GIS data. Updated MDNR Element Occurrence attribute data were used to estimate the NorthMet Project area and statewide population numbers of a species, per MDNR guidance (Joyal, MDNR, pers. comm., February 13, 2012). An individual is defined here as a single plant of a species. A colony (observation) is a group of individual plants of one species in a distinct geographic location. A population is a group of individuals or colonies of one species that may be separated geographically, but are close enough geographically to interbreed and persist over time.

No federally listed threatened or endangered plant species occur at the Mine Site. However, the NorthMet Project Proposed Action would have both direct (9 species) and indirect (2 species) effects on state-listed ETSC plant species at the Mine Site, affecting 1 percent of the known statewide populations for these 11 species. Table 5.2.4-3 summarizes the direct and indirect NorthMet Project Proposed Action effects on each of the ETSC plant species that are located in the vicinity of the Mine Site, which includes the Transportation and Utility Corridor. These numbers may overestimate the actual effects 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 actual number of statewide populations may be larger than that identified in the MDNR NHIS.

Table 5.2.4-3 Effects to Known State-listed ETSC Plant Populations in the Vicinity of the Mine Site, Including the Transportation and Utility Corridor

	Known Mine Site Populations					Known Statewide Populations				
Plant Species (state status/ global status[1])	**Total Populations[2,7]**	**Total Individuals**	**Direct Effects[3] (Populations)**	**Indirect Effects[4] (Populations)**	**Unaffected Populations**	**Total Known Populations[5,7]**	**Average Individuals per Population[6]**	**Percent Directly Affected (Populations)**	**Percent Indirectly Affected (Populations)**	**Total Percent Affected (Populations)**
Botrychium campestre (SC/G3)	1	1	1	0	0	69	unknown	1	0	1
Botrychium pallidum (E/G3)	1	21	1	0	0	99	15	1	0	1
Botrychium rugulosum (T/G3)	1	4	1	0	0	72	14	1	0	1
Botrychium simplex (SC/G5)	3	1,580	3	0	0	210	25	1	0	1
Caltha natans (E/G5)	1	56	1	0	0	12	unknown	8	0	8
Eleocharis nitida (T/G4)	1	~1,562 ft^2	1	0	0	49	450	2	0	2
Juncus stygius var. *americanus* (SC/G5)	1	1	0	1	0	30	unknown	0	3	3
Platanthera clavellata (SC/G5)	1	3	0	1	0	123	unknown	0	1	1
Ranunculus lapponicus (SC/G5)	1	~919 ft^2	1	0	0	83	51	1	0	1

	Known Mine Site Populations					Known Statewide Populations				
Plant Species (state status/ global status[1])	**Total Populations[2,7]**	**Total Individuals**	**Direct Effects[3] (Populations)**	**Indirect Effects[4] (Populations)**	**Unaffected Populations**	**Total Known Populations[5,7]**	**Average Individuals per Population[6]**	**Percent Directly Affected (Populations)**	**Percent Indirectly Affected (Populations)**	**Total Percent Affected (Populations)**
Sparganium glomeratum (SC/G4)	1	78	1	0	0	158	82	1	0	1
Torreyochloa pallida (SC/G5)	1	~25 ft^2	1	0	0	74	unknown	1	0	1
Total	**13**	**NA**	**11**	**2**	**0**	**979**	**NA**	**NA**	**NA**	**NA**

Source: MDNR 2011m; MDNR 2013a.

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 2011).
2 Populations are interpreted from MDNR NHIS data using Element Occurrence, which differs from the DEIS, which used colonies as the population estimate.
3 Direct effects are expected for those populations that would be removed or buried by mine activities. Effects are calculated for populations rather than individuals because of the large variation and inaccuracies in the estimates of number of individuals per population.
4 Indirect effects 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, effects are given for populations rather than individuals.
5 Statewide population data provided by Lisa Joyal (MDNR) on March 26, 2013. Population data for B. pallidum and B. rugulosum include additional populations found during project-specific surveys.
6 Population estimates are approximate and used for comparative purposes only. The number of individuals is based upon populations for which data exist.
7 Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

The NorthMet Project Proposed Action would directly affect 9 of the 11 stated-listed ETSC plant species found at or in the immediate vicinity of the Mine Site (Table 5.2.4-3). Most of the direct effects would involve the complete loss of colonies within a population as a result of excavation of the mine pits, burial under stockpiles, or disturbance during infrastructure construction.

The NorthMet Project Proposed Action would indirectly affect 2 of the 11 state-listed ETSC plant species found at or in the immediate vicinity of the Mine Site (Table 5.2.4-3). The NorthMet Project Proposed Action may also result in indirect effects to some colonies of the directly affected state-listed ETSC plant species at the Mine Site. These indirect effects may occur as a result of changes in hydrology or water quality, deposition of particulate matter (dust), application of road salts, or weed incursion. Individual species appear to differ in their response to these indirect effects. For example, several of the ETSC plant species typically occur along or 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. However, several species may not actually be disturbance-tolerant, as much as they are able to colonize previously disturbed sites. Repeated soil disturbance near these species may have an effect on such populations in the short term. Overall, less than 1 percent of the known statewide populations for these state-listed ETSC species would be indirectly affected by the NorthMet Project Proposed Action. In some cases, potential indirect effects on ETSC plant species that would be near, but outside, the footprint of these facilities could be avoided or reduced by fencing or flagging ETSC populations to prevent disturbance.

Minnesota's endangered species law (*Minnesota Statute*, § 84.0895) and associated rules (*Minnesota Rules*, parts 6212.1800–6212.2300 and 6134) impose a variety of restrictions, permits, and exemptions pertaining to ETSC species. "The law and rules prohibit taking, purchasing, importing, possessing, transporting, or selling" endangered or threatened plants, including their parts or seeds, without a permit (MDNR 2011m). "Taking," as it relates to plants includes picking, digging, or destroying. There is the potential that PolyMet would need to seek a Take Permit from the MDNR for state-listed ETSC plant species. If it is determined by the MDNR that there are no feasible alternatives to taking, the applicant must pursue compensatory mitigation. Transplantation is generally not considered by the MDNR to be acceptable mitigation for taking of endangered or threatened species (MDNR 2011m). The MDNR suggests that typical compensatory mitigation for taking endangered or threatened species in Minnesota include the following:

- 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 (MDNR 2011m).

A discussion of the effects on each individual ETSC species is provided below.

Botrychium campestre (prairie moonwort) populations are commonly observed on sparsely vegetated mineral soil from sediments of iron mine tailings ponds and grassy railroad embankments (NatureServe 2011). Of the 69 known populations statewide, one colony of one population within the Mine Site area, along Dunka Road, could be directly affected by pipeline construction and road improvements/maintenance as part of the NorthMet Project Proposed Action (1 percent affected) (Table 5.2.4-3). This species is less tolerant of disturbance than other *Botrychium* species; however, since it prefers sparsely vegetated areas, it may actually expand into disturbed areas along Dunka Road in the future. At the Mine Site, grassland areas would not be affected, but around 34 percent of previously disturbed areas would be affected, resulting in potentially reduced on-site habitat for this species (Table 5.2.4-1).

Botrychium pallidum (pale moonwort) populations are most commonly observed on mine tailings basins and along roadsides. Of the 99 known populations statewide, three colonies of one population within the Mine Site, along Dunka Road, could be directly affected by pipeline construction and road improvements/maintenance as part of the NorthMet Project Proposed Action (1 percent affected) (Table 5.2.4-3). One separate colony is located near the railroad track and may be indirectly affected. This species, however, appears to be semi-tolerant of disturbance since sites that are kept open by regular disturbance are particularly suitable (NatureServe 2011). Colonies may actually expand into newly disturbed areas along Dunka Road and at the Mine Site. Grassland areas at the Mine Site would not be affected, but around 34 percent of previously disturbed areas would be affected, resulting in reduced on-site habitat for this species (Table 5.2.4-1).

Botrychium rugulosum (ternate, or St. Lawrence, grapefern) often occurs on tailings basins, along roadsides, and in shaded wetland forests. Of the 72 known extant populations in Minnesota, one population (with four individuals) occurs along Dunka Road at the Mine Site (1 percent affected) (Table 5.2.4-3). This population may be directly affected by vehicle operation or road improvements and maintenance as part of the NorthMet Project Proposed Action. This species appears to be semi-tolerant of disturbance and populations. At the Mine Site, around 62 percent of upland conifer forests and around 55 percent of upland deciduous forests would be affected, resulting in much less on-site habitat for this species (Table 5.2.4-1).

Botrychium simplex (least moonwort) frequently occurs in shrublands, forests, tailings basins, and along roadsides. Of the 210 known populations statewide, three occur at the Mine Site, all of which are expected to be directly affected (Table 5.2.4-3). Of these populations, 21 colonies are expected to be directly affected—7 from stockpiles and mine pits, and another 14 from construction of the haul roads, water pipeline, ditches, railroad track, or transmission line (1 percent affected). The colonies affected by stockpiles and mine pits would be removed, while the colonies affected by construction of pipelines or ditches may be reduced in the short term. Depending on proximity to construction activities, some of these colonies would likely recover by expanding along Dunka Road and at the Mine Site post-closure, as this species appears to be semi-tolerant of disturbance. At the Mine Site, around 34 percent of disturbed areas and around 55 percent of shrublands would be directly affected, resulting in less on-site habitat for this species (Table 5.2.4-1).

Caltha natans (floating marsh-marigold) is found primarily in relatively undisturbed habitats and is not likely to be tolerant of disturbance. Of the 12 known populations statewide, one population, which consists of 13 colonies, occurs at the Mine Site (Table 5.2.4-3). One colony is expected to be directly affected by stockpile development. Two other colonies are located close to Dunka Road and could be indirectly affected by road construction or improvements. Ten other colonies are located in the vicinity of, but outside, the Mine Site, several of which occur along the Partridge River. Since water from the West Pit would be discharged downstream of these colonies, it is unlikely there would be indirect effects on them. Since the known statewide population for this species is rather small, the effect on its population in Minnesota would be correspondingly larger (8 percent affected). The mitigation measures mentioned above, particularly the purchase of an unprotected site with a population of the species, should be assessed. At the Mine Site, around 47 percent of aquatic environments would be directly affected, resulting in reduced on-site habitat for this species (Table 5.2.4-1).

Eleocharis nitida (neat spike-rush) at the Mine Site is primarily observed in roadside ditches along Dunka Road with gravel or sandy substrates. Of the 49 known populations in the state, one occurs on the Mine Site (2 percent affected) (Table 5.2.4-3). Of this population, eight colonies are found along Dunka Road, and three colonies are located along the railroad tracks. All of the eight Dunka Road colonies are likely to be directly affected by ditch construction. The other three colonies may be indirectly affected by changes in hydrology or water quality. This species seems to be semi-tolerant of disturbance since it has inhabited roadside ditches. At the Mine Site, around 47 percent of aquatic environments and 34 percent of disturbed areas would be directly affected, resulting in less on-site habitat for this species (Table 5.2.4-1).

Juncus stygius var. *americanus* (bog rush) has 30 known populations in the state, none of which occur at the Mine Site; however, one population is located upgradient of the Mine Site within the One Hundred Mile Swamp (Table 5.2.4-3). This population would not be directly affected; however, it may be indirectly affected by changes in hydrology (3 percent affected). At the Mine Site, around 56 percent of lowland coniferous forests would be directly affected, resulting in reduced habitat nearby for this species (Table 5.2.4-1).

Platanthera clavellata (club-spur orchid) has 123 known populations in the state, none of which occur at the Mine Site; however, one population is located upgradient of the Mine Site within the One Hundred Mile Swamp (Table 5.2.4-3). This population would not be directly affected; however, three colonies may be indirectly affected by changes in hydrology, since the species is sensitive to this type of change (1 percent affected). At the Mine Site, around 56 percent of lowland coniferous forests would be directly affected, resulting in reduced habitat nearby for this species (Table 5.2.4-1).

Ranunculus lapponicus (lapland buttercup) is found in conifer/sphagnum bogs on the Mine Site. Of the 83 known populations statewide, one population occurs at the Mine Site (1 percent affected) (Table 5.2.4-3). Of this population, three colonies are expected to be directly affected by construction of a waste rock stockpile. The other four colonies may be indirectly affected by changes in hydrology, water chemistry, or dust. This species may face short- and long-term effects at the Mine Site since it is most likely intolerant of disturbance. At the Mine Site, around 56 percent of lowland coniferous forests would be directly affected, resulting in much less on-site habitat for this species (Table 5.2.4-1).

Sparganium glomeratum (clustered bur-reed) has been observed along roadsides and in lowland forests. Of the 158 known populations statewide, one population occurs at the Mine Site (1 percent affected) (Table 5.2.4-3). Of this population, eight colonies would be directly affected—three colonies by construction of the mine pits and stockpiles, and five colonies along Dunka Road by construction of the water pipeline, railroad track, or transmission line. The remaining five colonies may be indirectly affected by changes in hydrology, water quality, or dust. This species may be slightly tolerant of some disturbance, since it can be found along disturbed wetland edges; however, short-term effects may be more pronounced than long-term effects. At the Mine Site, around 47 percent of aquatic environments and 56 percent of lowland coniferous forests would be directly affected, resulting in much less on-site habitat for this species (Table 5.2.4-1).

Torreyochloa pallida (Torrey's manna-grass) is often seen along roadsides and may be semi-tolerant of disturbance. Of the 74 known populations statewide, one occurs at the Mine Site (1 percent affected) (Table 5.2.4-3). Of this population, one colony along Dunka Road may be directly affected by construction of a transmission line. The remaining three colonies are located away from any proposed construction and may be sufficiently removed from potential direct and indirect effects of the NorthMet Project Proposed Action. At the Mine Site, around 47 percent of aquatic environments and 56 percent of lowland coniferous forests would be directly affected, resulting in less on-site habitat for this species (Table 5.2.4-1).

Regional Foresters Sensitive Species

The USFS RFSS data layer indicates there are no known RFSS plants on the federal lands, which include the majority of the Mine Site. However, several state-listed ETSC plant species known to exist on the Mine Site are also listed as RFSS plants in the Superior National Forest. Six of these species would be affected by the NorthMet Project Proposed Action, including *Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, and *Juncus stygius* var. *americanus*.

MIH types are not fully mapped for the Mine Site since not all of it consists of federal land, but MIH types are mapped for the federal lands located within the Mine Site. On this portion of the Mine Site, upland forest (MIH 1; 531 acres) would be affected the most of all MIH types, which means RFSS plant species listed under the upland forest category (Table 4.2.4-5) could be most affected by the NorthMet Project Proposed Action. Upland conifer forest (MIH 5; 505 acres) lands would be the next group most affected, though there is overlap of this category with upland forest since upland conifer forest occurs within upland forest types. Some RFSS species that occupy upland forest may also be affected by this category. Lowland black spruce-tamarack forest (MIH 9; 479.5 acres) would be subject to effects comparable to upland conifer forest, and the RFSS species listed in this category would be affected similarly. The lowland emergent wetland type would be affected (10.8 acres), and so the five RFSS plant species listed for that type may be minimally affected. Aquatic habitat (MIH 14) is not mapped at the Mine Site; however, there are some aquatic habitats on the parcel that would be affected and, thus, the RFSS species listed in this category may be affected. Section 5.2.6 provides further discussion of effects on aquatic habitats and species.

5.2.4.2.2 Transportation and Utility Corridor

<u>Effects on Cover Types</u>

Habitat Types

Construction and transportation activities within the Transportation and Utility Corridor, as part of the NorthMet Project Proposed Action, would affect all 120.2 acres of the MDNR GAP land cover designations (Table 5.2.4-4). The majority of effects would be on formerly disturbed (94.4 acres) and grassland areas (9.8 acres).

Table 5.2.4-4 Direct Effects on Cover Types at the Transportation and Utility Corridor

Cover Types	Affected Acres	Non-affected Acres	Total Cover Type Acres	Percent of Cover Type Affected
Disturbed	94.4	0	94.4	100
Cropland/grassland	9.8	0	9.8	100
Shrubland	7.7	0	7.7	100
Aquatic environments	2.7	0	2.7	100
Upland deciduous forest	2.7	0	2.7	100
Upland coniferous forest	2.6	0	2.6	100
Lowland coniferous forest	0.2	0	0.2	100
Lowland deciduous forest	0.0	0	0.0	100
Upland conifer-deciduous mixed forest	0.0	0	0.0	100
Total [1]	120.2	0	120.2	100

Source: MDNR 2006b.

[1] Total acres may be more or less than presented due to rounding.

Minnesota Biological Survey

The NorthMet Project Proposed Action would affect 22.5 acres of MBS Sites of High Biodiversity Significance (2.9 acres of the One Hundred Mile Swamp and 19.6 acres of the Upper Partridge River) within the Transportation and Utility Corridor. Similar to the Mine Site, this 22.5-acre area represents a very small portion of the mapped Sites of High Biodiversity Significance in St. Louis County (less than 1 percent) and the State of Minnesota (less than 1 percent). Habitat effects associated with the NorthMet Project Proposed Action would not result in a large percentage decline in those areas ranked as high by the MBS.

NorthMet Project Proposed Action activities within the corridor would also affect approximately 2 acres of “widespread and secure” native plant communities, including 2 acres of the aspen-birch forest: balsam fir subtype (FDn43b1), and less than 0.1 acre of the low shrub poor fen (APn91a).

Indirect Effects

Potential indirect effects on vegetative cover types along the Transportation and Utility Corridor could include those caused by dust from road traffic or spillage from rail cars. Section 5.2.4.2.1 provides further discussion on the effects of dust. The new proposed side-dump rail ore cars are a different design than the bottom-dump rail pellet cars that were used during past LTVSMC operations. The side-dump rail ore cars are designed to contain fine ore pieces to the center of the cars where they are unlikely to spill through the hinge gaps (PolyMet 2013c). Larger pieces of ore that are spilled from the cars would be recovered during routine maintenance of the track, thus minimizing indirect effects. Smaller effects in already-disturbed areas would occur along Dunka Road near the Mine Site. A water pipeline for treated water and a transmission line would be constructed along Dunka Road on previously disturbed land. Construction of the pipeline and transmission line would expose soil during construction and could bury vegetation under rock fill.

Reclamation

Dunka Road would not be reclaimed after the NorthMet Project area is closed, since it is an existing private road. Railroad track and ties that are not used by common carriers would be removed and recycled (PolyMet 2013c). The treated water pipeline between the Mine Site and Plant Site would be removed (PolyMet 2013a).

Effects of Invasive Non-native Plants

The Transportation and Utility Corridor is already disturbed, but contains no known occurrences of invasive species according to the Superior National Forest invasive plant geodatabase. Disturbance associated with the widening of Dunka Road and installation of the water pipeline, transmission line, and rail line would result in exposed soil surfaces that would have the potential for colonization of invasive species. Therefore, the general effects of invasive non-native plant species at the Transportation and Utility Corridor would be the same as the Mine Site or Plant Site.

Effects on Threatened and Endangered Plant Species

No federally listed threatened or endangered plant species occur within the Transportation and Utility Corridor. The NorthMet Project Proposed Action would have both direct and indirect effects on the same state-listed ETSC plant species as those found at the Mine Site. Since the populations occur along Dunka Road near or overlapping the Mine Site, they are discussed in Section 5.2.4.2.1 along with the effects on plant populations at the Mine Site. Table 5.2.4-3 summarizes the direct and indirect effects of the NorthMet Project Proposed Action on each of the ETSC plant species. As mentioned for the Mine Site, these numbers may overestimate the actual effects as a proportion of the number of actual populations in the state.

5.2.4.2.3 Plant Site

Effects on Cover Types

Habitat Types

Construction, operation, and closure of the NorthMet Project area at the Plant Site would have fewer effects on native vegetation than at the Mine Site because much of the Plant Site (61 percent) has already been heavily disturbed or is barren (Table 4.2.4-7). Most of the effects of the NorthMet Project Proposed Action are on disturbed areas or tailings ponds (Table 5.2.4-5), but other affected areas include isolated stands of forest or shrublands, both characterized as being in good to fair condition according to the MDNR condition ranking system (Table 4.2.4-7). Other effects on MDNR GAP land cover types at the Plant Site are smaller. Approximately 2,177.5 acres (48 percent) of the Plant Site would be affected by NorthMet Project Proposed Action activities. A description of the potential effects on wetlands north of the Tailings Basin is presented in Section 5.2.3.

Table 5.2.4-5 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
Disturbed	1,102.5	1,653.0	2,755.5	40
Aquatic environments	572.7	64.0	636.7	90
Upland deciduous forest	290.1	356.6	646.7	45
Shrubland	139.5	193.9	333.4	42
Upland coniferous forest	52.0	47.8	99.8	52
Lowland coniferous forest	20.7	21.2	41.9	49
Cropland/grassland	0.0	0.0	0.0	0
Lowland deciduous forest	0.0	0.0	0.0	0
Upland conifer-deciduous mixed forest	0.0	0.0	0.0	0
Total [3]	2,177.5	2,336.5	4,514.0	48

Source: MDNR 2006b.

1 This table reflects only those effects on plant populations occurring within the boundaries of the Plant Site. The table does not include the potential indirect effects on the wetlands north of the Tailings Basin due to hydrology changes.
2 Areas of cover types not within a 50-ft buffer of buildings, Tailings Basin/spillway reclamation area, or railroad connection.
3 Total acres may be more or less than presented due to rounding.

Minnesota Biological Survey

There are no MBS Sites of Biodiversity Significance or native plant communities identified at the Plant Site.

Indirect Effects

In addition to the direct effects mentioned above, indirect effects at the Plant Site could include dust or erosion. Vegetation would be established on tailings dams during construction to minimize erosion and fugitive dust (PolyMet 2012d). Water level would be managed in the Tailings Basin to limit the amount of exposed beach, which would minimize dust. Additionally, other fugitive dust control measures (e.g., mulching, temporary seeding, and dust suppressants) would be applied to inactive beaches. In the event erosion occurs on the Tailings Basin, it would be corrected and re-vegetated; if necessary for repetitive or excessive erosion, and channels or outfall structures would be designed to address the issue.

Reclamation

At closure, the buildings and other infrastructure at the Plant Site would be removed, and foundations would be razed and buried to a minimum depth of 2 ft with overburden material suitable for vegetation. Plant Site roads that are not deemed necessary for access by the MDNR would be scarified and vegetated, and asphalt from paved surfaces would be removed and recycled. These disturbed areas would be seeded with the same potential three mixes (native, non-native, or mixed) as those mentioned for disturbed areas in Section 5.2.4.2.1 (PolyMet 2012n).

The Tailings Basin would be incrementally reclaimed by a qualified professional pursuant to *Minnesota Rules*, part 6132.2700. As dams are constructed, exterior slopes would be stabilized and vegetated in accordance with requirements in the Fugitive Emissions Control Plan (PolyMet 2012d). Inactive interior beach areas would be temporarily vegetated as necessary for fugitive dust control, using oats, winter wheat, annual ryegrass, white clover, redtop, and alsike clover, or some combination of these species for various times of the year (PolyMet 2012n). The exterior dam faces would be permanently vegetated by a qualified reclamation contractor according to requirements of the Reclamation Seeding Plan. Upland areas would be planted with permanent vegetation and mulched to control potential fugitive dust in accordance with requirements in the Fugitive Emissions Control Plan. Upland beach areas would be planted with the same potential three mixes (native, non-native, or mixed) as that mentioned for disturbed areas in Section 5.2.4.2.1, while the dam slopes and benches would be planted with the same mix as that mentioned for the slopes of the Category 1 Stockpile (PolyMet 2012n). Interior portions would be graded to provide a gently sloping surface that effectively routes storm water runoff to the interior of the Tailings Basin and promotes wetlands creation between the beach and pond areas. Exposed beach areas would be amended with bentonite to limit oxygen infiltration into the tailings. The cover layer of tailings would be replaced and vegetated in accordance with requirements of the Reclamation Seeding Plan (PolyMet 2012d). Wet soils near the Tailings Basin pond would be planted with the same mix as that mentioned for the East Pit backfill and depressions in the temporary stockpile footprints (see Section 5.2.4.2.1) (PolyMet 2012n). Establishment of dense vegetative cover and root mass is among the most effective methods to minimize erosion, so the quality and density of the vegetation would be periodically reviewed after final reclamation construction is complete. Areas where vegetation does not become well established would receive additional seeding and/or fertilizer and other amendments in accordance with requirements of the Reclamation Seeding Plan. Reclamation areas would be inspected in spring and fall to repair erosion areas and failed seeding areas, until MDNR determines that the areas are stable and self-sustaining.

Reclamation of the Hydrometallurgical Residue Facility 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. The exterior slopes of the Hydrometallurgical Residue Facility dams would be incrementally reclaimed throughout the life of the mine. This would include stabilization and vegetation in accordance with *Minnesota Rules*, part 6132.3200. Final reclamation would generally consist of grading the cell area into a gently sloping surface. The cover would consist of a layer of LTVSMC tailings immediately above the drained residue. This would be topped, if necessary, with a non-woven needle-punched geotextile fabric. Next, a geosynthetic clay barrier layer and a 40 mm LDPE or similar MPCA-approved geomembrane barrier layer would be placed (PolyMet 2013c). Additional LTVSMC coarse tailings and/or common borrow and cover soils would be placed on top of the barrier layer to create a surface capable of sustaining a vegetated cover (PolyMet 2012e). The Hydrometallurgical Residue Facility dam slopes and benches would be planted with the same mix as that mentioned for the Category 1 Stockpile slopes in Section 5.2.4.2.1 (PolyMet 2012n). 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 implementing repairs.

The Colby Lake Water Pipeline Corridor would not be subject to any additional disturbance or effects as a result of the NorthMet Project Proposed Action. Maintenance activities would likely continue to occur on the pipeline.

Effects of Invasive Non-native Plants

The revegetation plan following closure at the Plant Site is similar to what is planned at the Mine Site as described above. Use of the proposed seed mix could introduce invasive non-native species, depending on which species are used, to an area of primarily native vegetation that surrounds the Plant Site. However, the existing LTVSMC Tailings Basin and most of the Plant Site are already heavily disturbed, and several invasive non-native species currently inhabit these areas (e.g., smooth brome grass, reed-canary grass, yellow sweet clover). 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. Generally, dominance by invasive non-native species would reduce the quality of native cover types and habitat remaining at the Plant Site.

Effects on Threatened and Endangered Plant Species

The NorthMet Project Proposed Action would likely have no effect on federal or state ETSC plant species at the Plant Site or Colby Lake Water Pipeline Corridor because none are known to occur within the boundaries of these areas, according to MDNR NHIS data. However, no site-specific studies have been conducted at the Plant Site and so potential species not reported in the NHIS data may not be represented.

5.2.4.2.4 Potential Mitigation Measures

Mine Site Mitigation Measures

A preferred mitigation measure would be to reseed with the native species, provided they can perform as effectively as the non-native species. In some areas where erosion control would be critical to prevent slope failures, non-native species may be needed. Temporary stabilization efforts using non-native species should use non-invasive plant species to minimize the long-term risk to surrounding plant communities. In the event invasive non-native species are used, an additional mitigation measure would be to implement a monitoring and control program for invasive species (including noxious weeds) to ensure these species do not overtake surrounding native communities.

Plant Site Mitigation Measures

The measures outlined in the Mine Site Mitigation Measures section above should be applied to the Plant Site as well. Another recommended mitigation measure may also benefit vegetation at the Plant Site specifically. The addition of organic amendments (peat) to the top foot of the Tailings Basin would improve soil and water quality and promote the development of shoreline and near-shore wetland vegetation.

5.2.4.3 NorthMet Project No Action Alternative

Effects on Cover Types

Under the NorthMet Project No Action Alternative, the Mine Site would not be developed, the Transportation and Utility Corridor would not be disturbed beyond routine maintenance, and the Plant Site would have no additional tailings added to the existing LTVSMC Tailings Basin. Forest-harvesting would continue to occur on the federal land portions of the Mine Site under the Forest Plan. While timber harvests would result in the immediate loss of some habitat types, permanent changes are not expected. The Forest Plan calls for an increase in older-age stands, which would likely come at the expense of younger-age stands in the long term. The majority of the federal lands are designated as General Forest – Longer Rotation Management Area, which correlates with the increase in older-age stands overall. The former LTVSMC processing plant would be reclaimed and revegetated in accordance with its separate closure plan sooner than under the NorthMet Project Proposed Action. Direct and indirect effects of the NorthMet Project No Action Alternative on cover types are considered minimal, as the Mine Site and portions of federal lands would continue to be managed in the same way they have been, and the Transportation and Utility Corridor and Plant Site have been disturbed in the past.

Effects of Invasive Non-native Plants

Invasive or non-native species may still invade the Mine Site as a result of logging, mineral exploration, vehicle traffic, and natural disturbances, but are likely to do so much more slowly than under the NorthMet Project Proposed Action. Invasive non-native species already exist at the Transportation and Utility Corridor and Plant Site, but they would likely spread more slowly under the NorthMet Project No Action Alternative than under the NorthMet Project Proposed Action due to less disturbance.

Effects on Threatened and Endangered Plant Species

Under the NorthMet Project No Action Alternative, colonies of state-listed ETSC plant species would not be affected. Timber harvests are expected to continue to occur on the federal land portions of the Mine Site. The NorthMet Project area has historically been logged and the state-listed ETSC plant species present on site have persisted. It is unlikely that continued logging, which now is more likely to employ best management practices to minimize detrimental effects, would affect the species in the long term. Likely indirect effects under the NorthMet Project No Action Alternative could come from increased competition as succession proceeds to older-age forest stands or with invasive non-native species. Effects of increased competition could include reduced spore production and consequently reduced population size in the early successional plant species (e.g., *Botrychium* spp.). Continued maintenance would likely occur along Dunka Road and the railroad where several of the *Botrychium* populations occur. Long-term succession at these locations is unlikely due to this maintenance, and these populations could persist given available habitats. The Transportation and Utility Corridor and Plant Site contain no occurrences of state-listed ETSC plant species and so the NorthMet Project No Action Alternative is not expected to have any effects.

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5.2.5 Wildlife

This section describes the environmental consequences of the NorthMet Project Proposed Action to wildlife including direct effects such as the loss of individuals/populations of affected species or a decrease in habitat, as well as indirect effects such as displacement, competition, or changes in the greater regional area.

Summary

The NorthMet Project Proposed Action is expected to affect one federally listed species, the Canada lynx, through localized direct decrease and fragmentation of designated critical habitat and the increased potential (albeit low) for incidental take resulting from vehicular collisions due to increased NorthMet Project Proposed Action-related traffic. 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, although this successional process could take decades. The NorthMet Project Proposed Action is not likely to affect the state-listed bald eagle, which is also protected under federal law (although not a federally listed endangered or threatened species). Four additional state-listed species, which include the gray wolf, the eastern heather vole, the wood turtle, and the yellow rail, may be affected by the NorthMet Project Proposed Action. It is expected that the Laurentian tiger beetle would not be affected. SGCN, RFSS, and other wildlife species, including those considered tribally or culturally significant, may be affected by human activity, noise and vibration, rail and vehicle traffic, and decrease of habitat.

5.2.5.1 Methodology and Evaluation Criteria

This section uses data presented in Section 4.2.5 to analyze effects on wildlife. Specifically, survey reports and GIS data were obtained regarding land cover and habitat types, forest stand age classes, listed ETSC, SGCN, RFSS, and other wildlife species. GIS analysis was used to calculate direct and indirect effects on these resources.

The analysis of direct effects included the potential of a take of federally or state-listed species. Pursuant to the federal ESA, *take* is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Take of an individual or population could occur for various reasons such as traffic collisions, habitat destruction, or change in an individual or population’s habitat use due to noise, other disturbance, or contamination of food or water sources. Take of a listed species would be considered a significant effect. The USFWS can issue a permit for the incidental take of a federally listed wildlife species consistent with the goal of conservation of the species. Permit applicants must design, implement, and demonstrate availability of funding for a conservation plan that minimizes and mitigates harm to the affected species during the proposed project. Without a permit, the take of a federally listed protected species is punishable by fines or imprisonment. Permitting for taking of a state-listed species is regulated by the MDNR.

Analysis was also conducted for potential 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 that cause mortality or reduced breeding and recruitment in the future population.

In addition to listed species, analysis was completed of potential direct and indirect effects on habitat types that affect population size and long-term viability for other species potentially at risk (SGCN, RFSS, and species of cultural concern). Direct effects could include vegetation removal by clearing, burial, or other destructive activity. Indirect effects could include changes within larger ecological units (e.g., the Laurentian Uplands or Partridge River Watershed), but not necessarily at the Mine Site or Plant Site, 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). Depending on the magnitude of the effect, direct effects may require mitigation.

5.2.5.2 NorthMet Project Proposed Action

This section describes the effects on wildlife due to construction and operation activities.

5.2.5.2.1 Federally Listed Species

As required under Section 7 of the ESA, the USACE and the USFS have initiated consultation with the USFWS regarding potential effects to federally listed species to ensure that actions they authorize or permit would not jeopardize listed species or designated critical habitats. Consultation is currently ongoing and will continue throughout the EIS process. The conclusions of the consultation process will be included in the FEIS.

Canada Lynx

In 2009, it was estimated that there were likely fewer than 200 lynx in Minnesota (Moen 2009). However, individuals can travel well beyond their home range, specifically when prey is scarce, at times more than 1,000 km (Moen 2010). Three individual lynx have been harvested in Ontario, approximately 400 road miles from their known locations in Minnesota.

The NorthMet Project area is currently within the 8,065 square mile designated critical habitat for the Canada lynx (USFWS 2008), which includes much of St. Louis, Lake, and Cook counties. Surveys did not find any evidence of lynx denning, foraging, or travel at the NorthMet Project area, but at least 20 different individual lynx were identified within 18 miles (ENSR 2006). A collared and studied lynx, L11, was identified adjacent to the NorthMet Project area, south of Dunka Road. This animal may have been using the NorthMet Project area for forage and travel as part of her home range between when she was collared in early 2004 and when she was trapped in Ontario, Canada in 2006.

Site clearing and mining activities associated with the NorthMet Project Proposed Action would potentially affect lynx by reducing available habitat and increasing habitat fragmentation. The total effect from increased activity is not known, as lynx have been known to habituate to increased human activity (Sunde et al. 1998). The NorthMet Project Proposed Action mining activities would disturb approximately 2 square miles (1,454.0 acres) of suitable lynx habitat, currently a mix of upland forest and lowland forest and bog. 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, although this successional process could 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 (ENSR 2006).

Assuming that the territory of a resident lynx is 28 square miles for males and 58 square miles for females, the reduction of habitat at the Mine Site corresponds to a reduction of three to seven percent of an individual's territory (ENSR 2006). Territory size expands in response to periods of reduced snowshoe hare density, and the related lynx and snowshoe hare populations tend to loosely follow a 10-year cycle, though other factors contribute to lynx population shifts. Surveys for the NorthMet Project Proposed Action were done during a low point in the lynx/snowshoe hare density cycle.

Though no lynx were identified during surveys, those that may currently be using the Mine Site could expand their territory into surrounding areas. Lynx density in the vicinity is considered low relative to the rest of the Minnesota lynx range (ENSR 2006). Individuals displaced from the Mine Site may be affected by increased stress and potential mortality due to utilization of unfamiliar territory and competition with other lynx or predator species. Although the NorthMet Project Proposed Action would result in a reduction and fragmentation of lynx habitat at the Mine Site, little to no effect on statewide lynx populations would occur as it is unlikely that an individual lynx or pair of lynx would be affected by the habitat decrease.

According to the USFS, LAUs are land areas identified for purposes of analysis and development of conservation measures for lynx (USFS 2004b). They range in size from just under 17,000 acres up to more than 91,000 acres. As discussed in Section 4.2.5.2.1, the federal lands (including the Mine Site) are located within LAU 12.

The USFS determined that approximately 1,078 acres, or 1.6 percent, of LAU 12 is currently unsuitable for lynx use (USFS 2011e). As noted above, the NorthMet Project Proposed Action would disturb 1,454 acres of lynx habitat, or approximately 3.8 percent of LAU 12 being unsuitable for lynx. This percentage is well within the Forest Plan condition that unsuitable habitat not exceed 30 percent of the LAU (USFS Unpublished Data 2009).

The increased vehicle traffic associated with the NorthMet Project Proposed Action mining activities could affect species such as the lynx. An average of 2,066 miles per day of vehicular traffic is expected within the Mine Site, primarily to haul ore to the rail siding and waste rock to the stockpiles (Table 5.2.5-1).

Table 5.2.5-1 Vehicle Traffic within the Mine Site Only

Vehicle type	Vehicle Weight (Tons)	Speed (Average MPH)	Total Road Miles in Mine Site	Annual Vehicle Miles Traveled (Estimated)	Estimated Average Total Miles Per Day (Estimated)
Haul Trucks and Construction Vehicles	81.5-425	12-14	15.3	61,400-979,000	2,066.0

Source: Barr 2012i.

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 effect on lynx. Current lynx use of the Mine Site appears to be very low; in the future, the area would be heavily affected by mining operations and not likely to be used by lynx.

The NorthMet Project area is currently within designated critical habitat for the Canada lynx (USFS 2008). Lynx may be affected by increased vehicle and train traffic. Lynx are highly mobile and lynx habitat can be found immediately adjacent to the corridor. The increased vehicle traffic associated with the NorthMet Project Proposed Action, including train and small vehicle traffic between the Mine Site and Plant Site, could potentially result in vehicle collisions with lynx (Table 5.2.5-2). The NorthMet Project Proposed Action would generate 1,734.9 miles of vehicle traffic between the Mine Site and Plant Site each day. This traffic would consist primarily of light trucks and maintenance vehicles traveling 30 to 45 mph and a few large fuel trucks, waste/supply trucks, and trains traveling 15 to 40 mph.

Table 5.2.5-2 Vehicular and Train Traffic Volume along the Transportation and Utility Corridor

Vehicle Type	Vehicle Weight (Tons)	Speed (Min – Max MPH)	Total Miles (Per Day)
Light Cars, Trucks, and Vans – primarily Mine Site to Area 2 Shops	2	30-45	961.1
Fuel Trucks, Supply and Waste Trucks	40	25-40	346.7
Haul Trucks	81.5 – 240	35	9.1
Trains	3,000	15-25	418.0
Total			1,734.9

Source: Barr 2012i.

Though vehicle traffic increases the chance of incidental lynx mortality, this species does not rely upon roads for travel (Moen 2010). Straight-line movement of collared lynx through the roadless BWCAW suggests that when roads are not available, lynx will still travel in a line where possible. As such, while lynx may be affected by vehicle traffic along the Transportation and Utility Corridor, the flat terrain near the NorthMet Project area would allow lynx to travel through the area.

Evidence of lynx was not found during surveys of the Plant Site. Approximately 76 percent of the Plant Site cover/habitat type is disturbed or aquatic, which is considered unsuitable lynx habitat. Lynx are unlikely to utilize the Plant Site, but may forage in the surrounding area. As such, activities at the Plant Site are unlikely to affect the Canada lynx.

State and federal forest lands near the Mine Site or Plant Site 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. Overall, the effects to the Canada lynx described above would result in the localized direct decrease and fragmentation of habitat, including designated critical habitat, and the increased potential (albeit low) for incidental take resulting from vehicular collisions; however, these effects are not anticipated to threaten the overall species population level and abundance in Minnesota.

5.2.5.2.2 State-listed Species

Gray Wolf

On May 4, 2011, the USFWS proposed to reinstate the April 2009 decision to delist the gray wolf population in the western Great Lakes after it was relisted in July 2009. This decision was finalized on December 26, 2011, and was effective January 27, 2012. The final rule also removes the designation of critical habitat in Minnesota.

Field surveys indicate the likelihood of a single wolf pack whose territory includes the Mine Site and Plant Site. The footprint of the Mine Site would remove approximately 2 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 small and is not expected to affect the highly mobile wolf population in the region, which is considered healthy by the MDNR. After closure, this area would again be available and suitable as wolf habitat, but, as described above for the lynx, this would not occur for more than 40 years.

Vehicle collisions are a cause of wolf mortality (Fuller and Harrison 2005). The increased vehicular activity associated with the NorthMet Project Proposed Action could potentially result in vehicle collisions with wolves. The haul road network would increase the road density (linear miles of road per square mile of habitat) 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 NorthMet Project Proposed Action on the gray wolf.

State and federal forest lands near the Mine Site or Plant Site 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. The gray wolf population in Minnesota (estimated at 2,922 gray wolves) is considered fully recovered by the MDNR as it has surpassed the federal delisting goal of 1,251 to 1,400 wolves. The MDNR established a hunting and trapping season for 2012, with a quota of 400 wolves (MDNR 2012i), split between an early hunting season and a later hunting and trapping season. Additional wolves may be taken if they pose a threat to people, pets, or livestock.

Overall the effects described above would result in the direct decrease and fragmentation of habitat suitable for the gray wolf, the increased potential for incidental take from vehicular collisions, and indirect decline in prey species due to habitat decrease. Together these factors are not anticipated to threaten the overall species population level and abundance in Minnesota.

Bald Eagle

Bald eagles typically nest in large trees within 500 feet of lakes or rivers (Guinn 2004). There are no large lakes or rivers at the Mine Site that would provide optimal nesting/foraging habitat, though the Partridge River (approximately 0.5 mile south of the Mine Site) would provide some, though less-than-optimal, habitat. The Partridge River is 4.9 miles south of the Plant Site, and the Embarrass River is 2.5 miles north and west. The USFWS National Bald Eagle Management Guidelines (USFWS 2007) suggest that human activity within 0.25 mile to 2 miles can be seen or heard 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 is, the greater the effect. If eagles were to nest on the portion of the Partridge River or the Embarrass River near the

NorthMet Project area, they could be within the 2-mile disturbance range. The nearest recorded bald eagle nest to the Mine Site is approximately 6.5 miles to the southeast (MDNR 2013a).

Bald eagle nesting territories in Minnesota generally have a 10-mile radius that varies with habitat quality (Guinn 2004). Bald eagle nests near the NorthMet Project area are on average 5.7 miles apart (3.8 to 9.4 mile range), which is less than the average territory radius. This suggests that the area is densely populated with bald eagle nesting territories and that no new eagles are likely to move into the area (MDNR 2013a). As eagles become more numerous, any eagles seeking to establish new territories in the area would need to select lower quality habitat and/or move into closer proximity to human activity.

Surface water contaminants (e.g., mercury) that are absorbed by prey species such as waterfowl could lead to ingestion of contamination by eagles (Marr 2008). However, bald eagles are relatively insensitive to the toxic effect of mercury exposure through their food (Judd 2013).

The NorthMet Project Proposed Action is not likely to affect bald eagles because the known nesting sites are more than 2 miles from the NorthMet Project area; optimal habitat for nesting and foraging bald eagles is not present at the Mine Site, Plant Site, or Transportation and Utility Corridor; and bald eagles are not sensitive to mercury exposure.

Wood Turtle

There is no habitat suitable for wood turtles at the Mine Site and no individuals are known to occur. Individuals could potentially use the southern riparian fringe of the Mine Site though no wood turtles are currently known to occur in the fringe areas that would be affected by the project. The fringe areas would also not be affected by activities at the Transportation and Utility Corridor. There is no suitable habitat for wood turtles at the Plant Site and no individuals are known to occur.

The predicted small decrease in Upper Partridge River flow during active mining 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 and become less suitable habitat for the wood turtle.

Wood turtles are not likely to be affected by project activities because there would be no direct loss of individuals, populations, or suitable habitat and the NorthMet Project Proposed Action would have no indirect effects on downstream habitat.

Eastern Heather Vole

The eastern heather vole has not been observed within 10 miles of the Mine Site nor has it been found in small mammal surveys in the region (Christian 1993; Jannett 1998). The NorthMet Project area is at the southern edge of its range. Approximately 1,445 acres of potentially suitable habitat exist at the Mine Site (Table 4.2.4-1), and there is potentially suitable habitat for the species along the Transportation and Utility Corridor. Additionally, there is potentially suitable habitat for the eastern heather vole at the Plant Site, 32 percent of which may be affected by the NorthMet Project Proposed Action (Table 5.2.4-4). The eastern heather vole could be present at the NorthMet Project area, but, if so, it is likely to be in very small numbers. Given the lack of known occurrences of eastern heather vole in the area, the habitat effects are unlikely to jeopardize the presence of eastern heather vole in Minnesota.

Yellow Rail

The yellow rail was not found during PolyMet's surveys at the Mine Site and was not reported in the NHIS database within 10 miles of the NorthMet Project area. Small, scattered areas of its preferred habitat, sedge/wet 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 39 acres at the Mine Site and 1.5 acres at the Plant Site; refer to Section 4.2.3). 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 that the NorthMet Project Proposed Action would affect the yellow rail.

Laurentian Tiger Beetle

The lack of suitable habitat and any NHIS recorded observations in the NorthMet Project area for the tiger beetle suggest that the species does not occur at the Mine Site, Plant Site, or Transportation and Utility Corridor. Therefore, the NorthMet Project Proposed Action should have no effect on the tiger beetle.

5.2.5.2.3 Species of Greatest Conservation Need

Along with federally and state-listed species, the NorthMet Project Proposed Action would affect SGCN at the Mine Site as a result of increased human activity and noise, collisions with vehicular and rail traffic, and decrease of habitat. Due to the number of SGCN species identified (Table 4.2.5-1) effects are classified by the type of disturbance.

Increased Human Activity

SGCN would be directly affected through increased human activity due to mining activities. Factors such as noise, dust, light, and vehicle traffic may frighten some species and discourage their use of otherwise suitable habitat. In general, suitable habitat is available in the area adjacent to the NorthMet Project area and most mobile wildlife species would be displaced. Following migration to new areas, displaced individuals could increase the competition for resources in their new habitat. Displaced species could also suffer increased mortality due to foraging in new areas. Less mobile species, such as herptiles (e.g., frogs, turtles), would likely incur relatively high mortality rates since they cannot quickly migrate from the area and would be more susceptible to changing habitat conditions. During the winter, a combination of plowing and sand, gravel, or salt (magnesium chloride) applications would be used to keep roadways passable. The potential exists for sand and salts to accumulate in the trenches adjacent to the roadways and affect less mobile species. These areas are not considered high quality habitat and are not likely to affect wildlife.

Effects related to trapping and hunting are unlikely because public access would be restricted. Through the Land Exchange Proposed Action, NorthMet Project area lands would enter into private ownership and would not be accessible for public use. The main access road (Dunka Road) is privately owned and would remain gated to prevent non-NorthMet Project Proposed Action-related access during mining operations and following mine closure.

Ground-nesting bird species and some raptor species have been known to utilize cliff areas for nesting and foraging. The SGCN include the northern goshawk, common nighthawk, and northern harrier. These birds could be affected by disturbance if they were to nest along the cliffs created by the pit rims.

Noise Effects

Noise associated with mining activities, including noise from vehicle and rail traffic, would likely affect wildlife. Mammals can be sensitive to sound levels below the range of human hearing, which is 20-16,000 hertz. The sensitivity thresholds for animals are generally lower, some below 20 hertz (US FHWA 2011). Effects due to acute noise (such as blasting) are not well studied, but would likely cause animals to startle and would interrupt forage or nesting activities (Larkin 1994). Noise does not appear to seriously affect invertebrates or fish, but does result in some disturbance to mammals (such as startling, forage interruption, and avoidance of the area of potential effect [Larkin 1994]). Bird communication would be masked by noise if the vocalizations are less than 18-20 dB above noise levels in the environment (US FHWA 2011). Changes in communication have been known to result in decreased reproduction and anomalies in learned vocalizations (Larkin 1994). Songbird populations have been shown to decrease with noise levels as low as 35 dB (Foreman and Alexander 1998). Section 5.2.8 provides further discussion on the noise modeling predictions for the NorthMet Project area. Though wildlife species are likely to be sensitive to changes in noise levels, there are no local, national, or international standards or limits that are applicable to the NorthMet Project Proposed Action. Wildlife species may be affected by noise in the NorthMet Project area, though adjacent habitat is available.

Vehicular and Rail Traffic Effects

Wildlife mortality generally increases with increasing traffic volumes and vehicle speed. In general, highly mobile species and habitat generalists (species that utilize a wide variety of habitats) are known to have higher road mortalities.

As discussed above, vehicular traffic would average 2,066 miles per day within the Mine Site (Table 5.2.5-1). Traffic effects from collisions with wildlife depend upon factors such as traffic volume, traffic speed, and the species involved. The potential for road effects increases if the roads are bordered by high-quality habitat or are crossed by wildlife travel corridors. The high density of affected wetlands at the Mine Site the haul roads may result in a relatively high rate of amphibian and reptile effects. Shrubs and trees near roadsides can increase road crossings by deer and birds. The barrier effect of roads is greater for small mammals, amphibians, and reptiles than for birds and large mammals (Kaseloo 2004). Species that utilize the small preserved forest island remnants between haul roads at the Mine Site would be most affected. Indirect effects from vehicle activities are expected locally at the Mine Site for SGCN species but would not be measurable at the scale of the Nashwauk and Laurentian Uplands or the Partridge River Watershed.

Effects at the Transportation and Utility Corridor are primarily related to vehicle and rail traffic. Travel between the Mine Site and Plant Site is expected to average 1,735 miles per day with travel speeds averaging between 15 and 45 mph, with trains, fuel, and waste/supply trucks traveling somewhat slower (Table 5.2.5-2). SGCN may be affected by noise and light associated with vehicle and rail traffic, and by collisions with vehicles or trains.

Transportation effects at the Plant Site are primarily related to vehicle traffic associated with construction of the NorthMet Project Proposed Action. Typical daily operations at the Plant Site would generate approximately 828 miles of vehicle traffic, primarily light trucks. Though noise and light may affect SGCN at the Plant Site, the disturbed nature of the area would mean that effects would be negligible.

Wildlife Habitat Effects

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 NorthMet Project Proposed Action. The changes in cover type are summarized in Table 5.2.5-3.

Table 5.2.5-3 Direct Effects on Key Habitat Types

Key Habitat Types	Total Acres[1] of Cover Type Present at Mine Site (Total Acres[1] of Cover Type Directly Affected)	Total Acres[1] of Cover Type Present at Transportation and Utility Corridor (Total Acres[1] of Cover Type Directly Affected)	Total Acres[1] of Cover Type Present at Plant Site (Total Acres[1] of Cover Type Directly Affected)
1.**Mature Upland Forest, Continuous Upland/Lowland Forest** (MIH1-13)	2,627.2 (1,535.3)	5.5 (5.5)	788.4 (362.8)
2.Open Ground, Bare Soils (no MIH)	128.0 (44.0)	94.4 (94.4)	2,755.5 (1,102.5)
3.Grassland and Brushland, Early Successional Forest (no MIH)	246.6 (133.2)	17.5 (17.5)	333.4 (139.5)
4. Aquatic Environments (MIH 14)	12.7 (6.0)	2.7 (2.7)	636.7 (572.7)
Total	**3,014.5 (1,718.5)**	**120.1 (120.1)**	**4,514.0 (2,177.5)**

Data from Tables 5.2.4-1, 5.2.4-4, and 5.2.4-5.

[1] Total acres may be more or less than presented due to rounding.

Mature Upland/Lowland Forest

At the Mine Site, approximately 1,535 acres (58 percent) of the mature forest would be lost as a result of the NorthMet Project Proposed Action. All of the SGCN found in this mature upland forest habitat are birds (Table 4.2.5-1), which would be displaced, but likely not injured or killed, during mine construction and operation. Nesting birds could be affected during the breeding season, especially during brooding and until fledglings become independent. Reclamation of the Mine Site would include revegetating nearly all disturbed ground according to Minnesota Rules, part 6132.2700.

Of the 5.5 acres of mature upland/lowland forest along the Transportation and Utility Corridor, all 5.5 acres would be affected. As such, activities would affect SGCN in mature upland/lowland forest habitat along the Transportation and Utility Corridor, though effects would be narrow and primarily located along the corridor.

Most of the Plant Site is developed or disturbed with only approximately 17 percent (788 acres) consisting of forest habitat (Table 5.2.5-3). Approximately 363 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 (MDNR 2013a). Therefore, activities at the Plant Site would not have an effect on SGCN using mature upland/lowland forest habitat.

Reclamation and revegetation of the NorthMet Project area would initiate vegetative succession on stockpiles, the East Pit and Central Pit, and Mine Site infrastructure (PolyMet 2012s). The Category 1 Stockpile would be incrementally and progressively reclaimed throughout the life of the mine through contouring the stockpile to provide topographic variety, covering with a layer of evapotranspiration soil, and finally seeding of grasses and forbs.

Reclamation and re-vegetation of the NorthMet Project area would improve wildlife habitat relative to conditions during mine operations; however, the quality of habitat for SGCN 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 using open ground or bare soils at the Mine Site, Transportation and Utility Corridor, or Plant Site is small. These areas were the result of past mining activity, are generally of low-quality, and are expected to decrease after mine closure as a result of reclamation.

Therefore, NorthMet Project Proposed Action effects on open ground/bare ground habitat should result in little effect on wildlife.

Brush/Grassland

Approximately 133 of the 247 total acres (54 percent) of brush/grassland at the Mine Site would be directly affected by the NorthMet Project Proposed Action. Brush and grassland (including early successional forest) at the Mine Site and Plant Site consist of small vegetative patches that are generally not suitable for SGCN. Young trees (less than four inches dbh) make up most of this habitat type (ENSR 2005). One SGCN associated with this habitat type, the American woodcock, was observed by USFS personnel at the Mine Site. The least weasel may occur as well. Most of the other SGCN (Table 4.2.5-1) are associated with large patches of grassland and savanna habitats, which are not present at the Mine Site.

Stands of brush/grassland (including early successional forest) along the Transportation and Utility Corridor consist of small vegetative patches that are generally not suitable to SGCN. Young trees (less than 4 inches dbh) make up most of this habitat type (ENSR 2005). Most of the other SGCN (Table 4.2.5-1) are associated with large patches of grassland and savanna habitats. Though all 17.5 acres of brush/grassland at the Transportation and Utility Corridor would be directly affected, activities at the Transportation and Utility Corridor would not affect grassland/brush SGCN based on the fragmented nature of this habitat.

Similar to the Mine Site, brush/grassland (including early successional forest) at the Plant Site consists of small vegetative patches that are generally not suitable to SGCN. Young trees (less than four inches dbh) make up most of this habitat type (ENSR 2005). Most of the other SGCN (Table 4.2.5-1) are associated with large patches of grassland and savanna habitats. Approximately 140 of the 333 acres of brush/grassland at the Plant Site would be directly affected by the activities at the Plant Site. The reclaimed Plant Site, specifically the Tailings Basin, would be revegetated with grassland vegetation species. Overall, the NorthMet Project Proposed Action would have no adverse effects on grassland/brush SGCN.

During reclamation, PolyMet would remove or cover portions of the existing road, railroad, and ditch and dike systems and restore them. Reclamation of these areas, which currently constitute poor wildlife habitat, would ultimately enhance wildlife habitat when compared to current conditions. Some SGCN, such as the eastern meadowlark, northern harrier, and common nighthawk would most likely use the grasslands until they are replaced by early successional forest about 20 to 50 years after closure. Early successional forests are likely to support the two SGCN: white-throated sparrow and American woodcock.

Open Water

SGCN such as the black duck, American bittern, and swamp sparrow utilize open water habitats. The NorthMet Project Proposed Action would create approximately 321 acres of open water at the Mine Site by eventually flooding the West Pit, which is estimated to fill in year 40. The West Pit would be fenced as a deterrent to wildlife species even though 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. Ponds at the wastewater treatment facilities would also be fenced to prevent wildlife from using the water. At the Plant Site, open water habitat primarily occurs in the existing LTVSMC Tailings Basin. None of the SGCN targeted during a 2005 survey 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 goose and ducks. Existing open water habitat would be maintained during operations, though the acreage of open water would fluctuate according to processing needs.

Wildlife, specifically aquatic birds, may utilize open water habitat created by the NorthMet Project Proposed Action. Unlike arid states such as Nevada, pit lakes and tailings basins are not the only readily available source of open water for wildlife use. Minnesota has over 13 million acres of lakes and wetlands, and the NorthMet Project Proposed Action would result in less than one hundredth of a percent increase in habitat. Because adjacent habitat is abundantly available, the pit lake and waste water treatment ponds would be fenced, and high-quality foraging habitat would not be present in these open bodies of water, surface water habitat effects on wildlife would likely be minimal.

Additionally, surface water quality standards do not apply to the pit lake or Tailings Basin. Any discharge water, such as the pit lake overtopping, would be treated in order to meet water quality standards and, as such, would not likely affect wildlife species.

Wetlands

Of the wetland-related SGCN, the marbled godwit and olive-sided flycatcher were surveyed for, but not found (ENSR 2005). The bog copper butterfly also was not found during surveys and there are no known NHIS records of any sightings within 12 miles of the Mine Site. As discussed above, the black duck, American bittern, and swamp sparrow are not likely to be present because they require open water and non-forested wetlands, which are relatively scarce at the Mine Site. The red-backed salamander is primarily an upland species, but may be present along the edges of mixed hardwood swamps. 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 (MDNR 2006d).

Based on the site-specific wetland delineation, the NorthMet Project Proposed Action would directly affect 758.2 acres of wetlands at the Mine Site, primarily coniferous bog (508.3 acres directly affected), shrub swamp (97.8 acres directly affected), and coniferous swamp (70.3 acres directly affected). These wetland types are common in the Partridge River Watershed. Consequently, the decrease of this habitat at the Mine Site is expected to displace wildlife into surrounding similar habitat, which would be large enough to absorb the displaced wildlife.

There are 7.2 acres of wetlands/open water along the Transportation and Utility Corridor, and those 7.2 acres would be affected by activities along the corridor. There are 147.1 acres of affected wetland at the Plant Site and Colby Lake Water Pipeline Corridor (Table 4.2.3-7). On-site wetland use by the SGCN described above may be limited, and these wetlands are generally considered to be of low quality.

Wetland mitigation is proposed both on-site and off-site. Approximately 101.8 acres of wetland creation is proposed for on-site mitigation. This would not replace in-kind the wetland habitat affected (primarily coniferous bog and shrub/conifer swamp). Off-site mitigation would consist of 1,856.4 acres of wetland creation of various habitat types at three sites.

Multiple Habitats

Species using multiple habitats and known to occur on or near the NorthMet Project area (e.g., gray wolf, Canada lynx, least flycatcher) are discussed above. Most multiple-habitat SGCN use mature/continuous and early successional forest. NorthMet Project Proposed Action effects are therefore largely limited to the mature/continuous forest habitats described above.

Wildlife Corridors

There is one wildlife corridor located approximately 0.5 mile northwest of the Mine Site. Mine Site operations, which provide a source of disturbance from noise and mining activity, would indirectly affect the corridor by reducing the effective, undisturbed size of 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 Site and Plant Site would increase as a result of the NorthMet Project Proposed Action. While the Transportation and Utility Corridor is outside of wildlife corridors, it runs parallel to the wildlife corridors and would potentially affect wildlife use.

Additionally, there is one wildlife corridor located approximately 1 mile southeast of the existing Plant Site. 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 effect 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 would not be complete barriers to wildlife movement (Barr 2009a).

Regional Forester Sensitive Species

Of the 18 terrestrial RFSSs on the 2011 list for the Superior National Forest, four of these are also state-listed ETSC species (gray wolf, bald eagle, wood turtle, and eastern heather vole) and are discussed above. Seven other RFSS (the boreal owl, olive-sided flycatcher, bay-breasted warbler, Connecticut warbler, taiga alpine, Freija's grizzled skipper, and Nabokov's blue) are on the SGCN list and are discussed by habitat type in Table 4.2.5-1 and above. The remaining seven species, including the northern myotis, eastern pipistrelle, little brown bat, northern goshawk, great gray owl, three-toed woodpecker, and Quebec emerald are discussed below.

Baseline acoustic surveys for bats, which include the northern myotis, the eastern pipistrelle, and the little brown bat, have been completed and data are still being analyzed by the Superior National Forest and the Natural Resources Research Institute of the University of Minnesota Duluth. These species may utilize forage habitat at the Mine Site, but there are no caves or mine shafts that could be used for hibernation. The three RFSS bats may forage along the edge habitat at the Transportation and Utility Corridor, but there are no caves or mine shafts present that may be used for hibernation. Bats have occasionally been observed in Plant Site buildings, but do not hibernate or roost in great numbers at the Plant Site. As such, bat species are not expected to be affected by NorthMet Project Proposed Action development.

The northern goshawk may occasionally be present at the Mine Site, since nest sites have been identified by the USFS approximately 0.75 mile west of the Mine Site and near the proposed East Pit and Central Pit areas. The NorthMet Project Proposed Action would directly affect one of the two known nest site areas, though that nest has not been occupied in recent years (AECOM 2009a). The northern goshawk may be occasionally present at the Transportation and Utility Corridor, since active nest sites have been identified on and adjacent to the Mine Site. No nests are known to occur at the Plant Site. Because the northern goshawk has nested in the area in the past and was identified during calling surveys, activities at the Mine Site may affect the northern goshawk.

During owl surveys (AECOM 2009a), one great gray owl was observed foraging along the Transportation and Utility Corridor near the Mine Site, though no nest was observed. A great gray owl had used a historic goshawk nest at the Mine Site, but did not return to the nest in the following year. Only three great gray owl nests have been observed in the Superior National Forest in recent years (AECOM 2009a). Owls are sensitive to disturbance, so populations would be unlikely to use the NorthMet Project area during mine operations.

Systematic survey data for three-toed woodpeckers are lacking; however, one bird was observed during overall 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. Though not surveyed, the Transportation and Utility Corridor and Plant Site lack the old-growth forest or recent burn habitat preferred by the three-toed woodpecker. Woodpeckers are sensitive to disturbance and would not be expected to use the Transportation and Utility Corridor or Plant

Site. Because existing populations are estimated to be low, three-toed woodpecker populations are not expected to be affected.

The Quebec emerald dragonfly inhabits poor fens, a wetland type not identified at the Mine Site but similar to the sedge/wet meadow that is present. Approximately 38.1 of the existing 39.5 acres of wet meadow/sedge meadow at the Mine Site would be affected by mining activities. The presence of the Quebec emerald dragonfly in the region and the existence of similar habitat at the Mine Site suggest that this species may be affected. There are no poor fens found along the Transportation and Utility Corridor or Plant Site, though approximately 1.5 acres of sedge/wet meadow are present at the Plant Site, and 1.4 acres would be affected by activities. There has only been one documented occurrence of this species in Minnesota (Lake County in 2006, more than 20 miles east of the NorthMet Project area) (Minnesota Odonata Survey Project 2009); therefore, the likelihood of observing Quebec emerald dragonfly individuals or populations within the vicinity of the NorthMet Project area is low. As such, this species is not expected to be affected.

Other Wildlife Species

Other wildlife species in the NorthMet Project area, including common and/or game species (such as white-tailed deer, moose, fox, bear, porcupine, etc.) would likely be affected in ways similar to special status species. Mobile individuals would avoid direct effects but may be indirectly affected by a decrease of habitat. Given the adjacent habitat available to these species, local effects are expected, but these would not threaten overall populations. Effects on wildlife species important to the Bands are discussed in Section 5.2.9 on a connected ecosystems level.

5.2.5.3 NorthMet Project No Action Alternative

5.2.5.3.1 Mine Site

Under the NorthMet Project No Action Alternative, mining would not occur. As described in Section 5.2.4.3.1, forest harvesting would continue to occur in portions of the federal lands, including the Mine Site. While timber harvests would result in the immediate decrease of some habitat types, permanent changes are not expected and conversion from one habitat type to another would benefit some species. Direct and indirect effects of the NorthMet Project No Action Alternative on wildlife and their habitat types are not expected, as the federal lands would continue to be managed as they currently are. Species individuals may still be affected due to existing land use (timber harvest, exploration, vehicle traffic, etc.) but effects are less than those expected under the NorthMet Project Proposed Action. The use of privately owned land at the Mine Site would also determine effects to wildlife under the NorthMet Project No Action Alternative.

5.2.5.3.2 Plant Site

Under the NorthMet Project No Action Alternative, the former LTVSMC processing plant would be reclaimed and areas revegetated in accordance with the Reclamation Plan much sooner than under the NorthMet Project Proposed Action. Revegetation would restore habitat for some species. Species individuals may still be affected due to disturbances related to reclamation, but effects are less than those expected under the NorthMet Project Proposed Action.

5.2.6 Aquatic Species

This section describes the potential effects of the NorthMet Project Proposed Action on fish and aquatic macroinvertebrate communities, especially special status species, associated with waterbodies found in the NorthMet Project area. These potential effects include changes in physical habitat (including flow), riparian and aquatic connectivity, and water quality.

Summary

The NorthMet Project Proposed Action could affect aquatic physical habitat via changes in flow, affect riparian and aquatic connectivity by construction activities within the riparian zone, affect water quality by increasing solute concentrations above Class 2 standards, and, as a result of these changes, potentially impact special status species (i.e., federal or state listed threatened and endangered species, RFSS, and MDNR SGCN).

The NorthMet Project Proposed Action would reduce flow in the Partridge River by a maximum of about 6 percent and reduce flow in the Embarrass River tributary streams draining the Tailings Basin by a maximum of about 20 percent, which would fall into the range of annual natural variability in terms of precipitation and are not anticipated to result in any measurable impact to available aquatic habitat in any streams in the NorthMet Project area.

The NorthMet Project Proposed Action activities would not occur within the riparian buffer of any streams; therefore the NorthMet Project Proposed Action would not affect the extent of natural vegetative cover along riparian areas and would not result in a decrease in the RCI. The NorthMet Project Proposed Action would also not result in any new dams, bridges, or culverts within perennial or intermittent streams; therefore, the NorthMet Project Proposed Action would not affect the hydrologic connectivity along streams and would not result in a decrease in the ACI.

Water quality modeling (see Section 5.2.2) predicts that the NorthMet Project Proposed Action would meet all Class 2 (aquatic life) water quality standards with the possible exception of aluminum and lead. For aluminum, ambient water quality already exceeds the Class 2 standard in both the Partridge River and Embarrass River. In the Partridge River, the NorthMet Project Proposed Action would not measurably increase aluminum concentrations relative to the No Action Alternative. In the Embarrass River, the increase in concentration relative to the No Action Alternative would be due to capturing relatively low concentration seepage from the Tailings Basin and increasing the relative contribution of higher concentration ambient groundwater and surface waters. In terms of lead, the two potential exceedances would not reflect an actual increase in lead loadings from the NorthMet Project Proposed Action, but rather a reduction in hardness as a result of the proposed groundwater containment system, which would lower the water quality standard for lead because it is hardness-based. Overall, the NorthMet Project Proposed Action is not expected to result in any increased loading and/or exceedances of Class 2 water quality standards relative to the NorthMet Project No Action Alternative.

In terms of special status species, there are no federal or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the NorthMet Project area (USFWS 2011). There are three special status aquatic species (i.e., RFSS and SGCN) that have not been found in the NorthMet Project area, but suitable habitat is likely to occur and the species could be present.

However, since the NorthMet Project Proposed Action is not predicted to result in any measurable changes in flows, no effects on RCI and ACI, and no change in water quality for any of the Class B water quality standards, no impacts to aquatic special status species is expected within the Embarrass River Watershed.

5.2.6.1 Methodology and Evaluation Criteria

The operation, reclamation, and closure of the NorthMet Project Proposed Action may result in changes in the physical aquatic habitat or water quality that would result in effects on fish and aquatic species. To assess these effects, predicted changes in water quality and flow, as presented in Section 5.2.2, were used in combination with data on existing aquatic biota conditions, as discussed in Section 4.2.6, to determine potential effects on aquatic biota in surface waterbodies located in the NorthMet Project area.

The following criteria were considered in this evaluation:

- physical alteration of stream conditions and the effect on fish and macroinvertebrate assemblages;
- numeric water quality standards established for the protection of aquatic life in affected waterbodies;
- the structure or function of the aquatic species assemblages in affected stream segments; and
- effects on one or more protected aquatic species or their habitat.

With respect to mercury, the criteria is an increase in the body burden of mercury in aquatic biota since this is the primary mechanism through which mercury affects aquatic life.

5.2.6.2 NorthMet Project Proposed Action

5.2.6.2.1 Partridge River

This section describes the potential effects of the NorthMet Project Proposed Action on aquatic resources in the Partridge River Watershed, including effects on physical habitat, riparian and aquatic connectivity, and water quality.

Physical Habitat Effects

Hydrologic changes often have major effects on fish and aquatic macroinvertebrates. While many aspects of the hydrologic regime can be important to the maintenance of fish and macroinvertebrate assemblages, reduction in baseflow (the portion of streamflow from groundwater) is particularly relevant because it represents a loss of habitat.

In the Partridge River, results of the water modeling (described in Section 4.2.2), as predicted from monitoring station SW-004a, were used to describe predicted flow for the upper Partridge River Watershed within the vicinity of the Mine Site. SW-004a was used due to its geographical location (see Figure 5.2.6-1), which likely represents the area that would best describe potential maximum effects along the Partridge River.

At SW-004a, baseflow (i.e., average 30-day annual low flow) gradually decreases during the first 11 years of mining, but at the worst case only represents a 6 percent reduction and a 0.16 cfs reduction in absolute flow (year 11). In terms of long term closure, the average annual 30-day minimum flow is predicted to increase from 2.53 cfs (existing conditions) to 3.08 cfs (Table 5.2.6-1).. The annual daily mean flow would follow similar trends as the 30-day annual low flow, with a maximum decrease of 4.4 percent at year 11 and a slight increase for long-term closure. These changes in flow would not be measurable and therefore hydrologic alteration is not expected to degrade physical aquatic habitat by destabilizing the stream channel.

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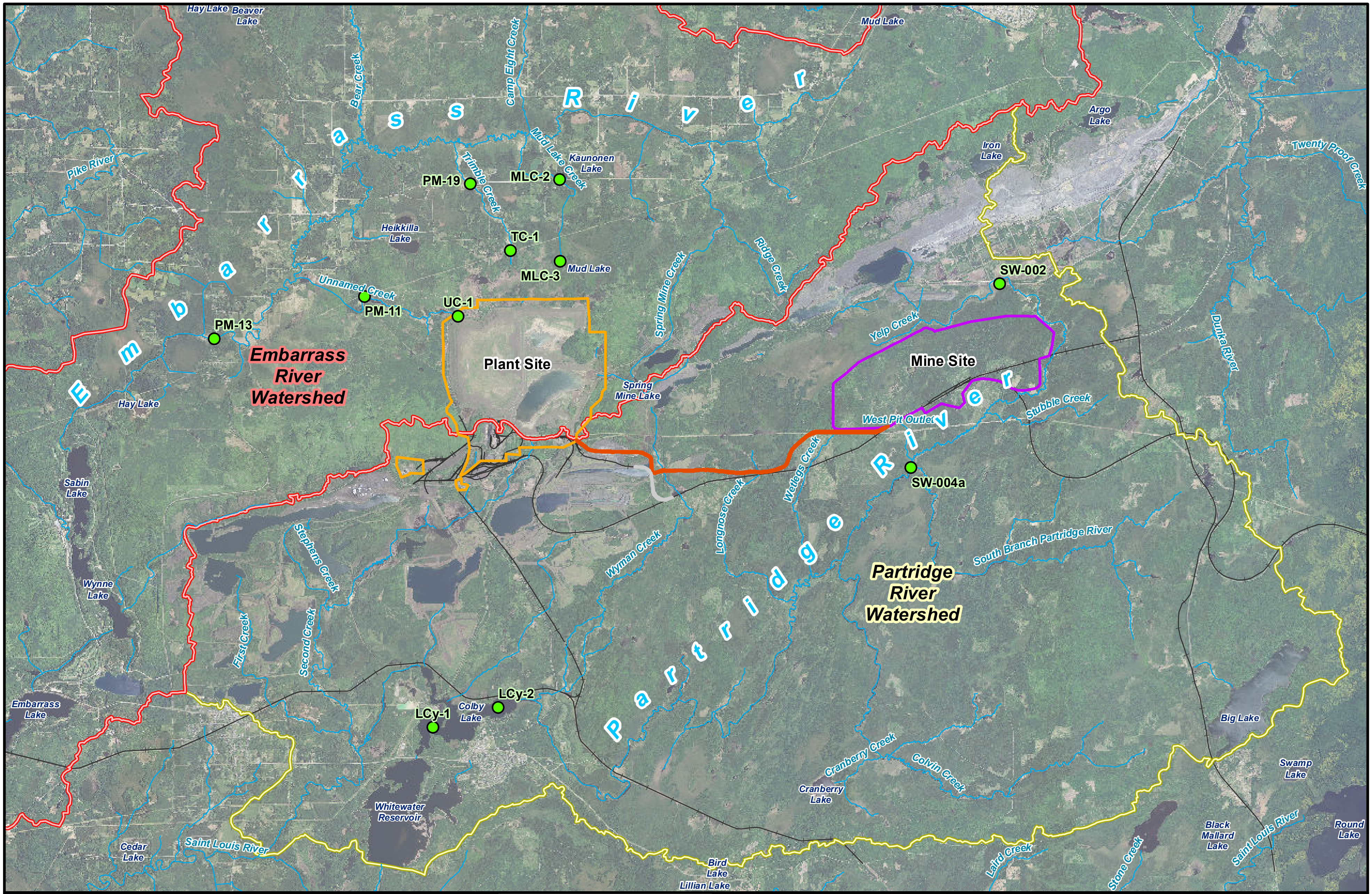

- Water Sampling Location
- Embarrass River Watershed
- Partridge River Watershed
- Stream/River
- Existing Railroad
- Mine Site
- Plant Site
- Transportation and Utility Corridor
- Railroad Connection

Minnesota Department of Natural Resources

US Army Corps of Engineers St. Paul District

Forest Service U.S. Department of Agriculture

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N W E S

0 0.5 1 2 3 Miles

Figure 5.2.6-1

Partridge and Embarrass River Watershed Surface Water Evaluation Locations

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Table 5.2.6-1 Partridge River Flow Modeling Results for Evaluation Location SW-004a

Statistic (Unit)	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	29.17	28.71	28.62	27.89	28.40	28.23	29.46
October Mean (cfs)	52.85	52.01	51.84	50.48	51.39	51.08	52.81
November Mean (cfs)	17.86	17.20	17.14	16.77	17.03	16.96	17.87
December Mean (cfs)	5.61	5.38	5.36	5.25	5.32	5.30	6.02
January Mean (cfs)	3.28	3.18	3.17	3.09	3.14	3.12	3.82
February Mean (cfs)	8.03	7.90	7.87	7.67	7.81	7.76	8.56
March Mean (cfs)	43.24	42.83	42.67	41.47	42.30	41.99	43.66
April Mean (cfs)	108.99	107.09	106.74	104.09	105.89	105.29	108.06
May Mean (cfs)	31.85	31.40	31.32	30.53	31.11	30.90	32.21
June Mean (cfs)	22.20	22.10	22.02	21.47	21.87	21.76	22.84
July Mean (cfs)	15.03	14.85	14.76	14.38	14.65	14.56	15.50
August Mean (cfs)	18.24	18.17	18.29	17.82	18.15	18.06	19.09
September Mean (cfs)	22.75	22.34	22.20	21.61	22.01	21.85	22.97
Average Annual 30-day Max (cfs)	146.83	144.89	144.63	140.98	143.48	142.71	146.29
Average Annual 90-day Max (cfs)	74.55	73.44	73.25	71.39	72.67	72.24	74.40
Average Annual 30-day Min (cfs)	2.53	2.46	2.44	2.37	2.41	2.39	3.08
Average Annual 90-day Min (cfs)	3.25	3.16	3.14	3.07	3.11	3.09	3.79
Avg. Hydrograph Increase (cfs/day)	23.91	24.15	24.21	23.40	23.75	23.95	24.27
Avg. Hydrograph Decrease (cfs/day)	7.88	8.01	8.02	7.85	7.95	8.01	8.09

Source: Barr 2012g.

No effects are anticipated from hydrologic changes ***at the Partridge River tributary streams,*** Colby Lake***, or*** Whitewater Reservoir, from the NorthMet Project Proposed Action.

Approximately 500 gpm of seepage flows from the existing LTVSMC Tailings Basin to the headwaters of Second Creek. Under the current LTVSMC Consent Decree, this seepage is captured and pumped back to the Tailings Basin, resulting in a net reduction in base flow to Second Creek. The NorthMet Project Proposed Action would continue pumping this seepage back to the Tailings Basin for water quality protection reasons, but would augment flows in Second Creek at approximately 80 percent of the current seepage volume (i.e., about 400 gpm) with a combination of WWTP effluent and/or Colby Lake water throughout NorthMet Project Proposed Action operations, reclamation, and long term closure. The proposed 80 percent of historic flow augmentation volume would fall into the range of annual natural variability in precipitation and stream flow (PolyMet 2013b); therefore, the designed flow augmentation to Second Creek would not affect the available aquatic species habitat by degrading the habitat with decreased flow to the headwater portions of this stream and would in fact help mitigate the hydrologic impact associated with the current pump back requirements.

Riparian and Aquatic Connectivity

The NorthMet Project Proposed Action activities would not occur within the riparian buffer of any streams; therefore, the NorthMet Project Proposed Action would not affect the extent of natural vegetative cover along riparian areas and would not result in a decrease in the RCI for the Partridge River.

The NorthMet Project Proposed Action would not result in any new dams, bridges, or culverts within perennial or intermittent streams; therefore, the NorthMet Project Proposed Action would not affect the hydrologic connectivity along streams and would not result in a decrease in the ACI for the Partridge River.

Water Quality Effects

Surface water chronic 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).

As described in more detail in Section 5.2.2, the GoldSim water quality model results were screened to compare the single highest monthly P90 water quality prediction from among 2,400 months covered over the 200 year model period by the simulation with the NorthMet Project No Action Alternative modeled values and the water quality evaluation criteria (Section 5.2.2.1). The screening analysis indicates that the NorthMet Project Proposed Action would meet all Minnesota Class 2 water quality standards and proposed evaluation criteria with the exception of aluminum (Table 5.2.6-2).

The results indicate aluminum would exceed the Class 2B standard (125 µg/L) at all evaluation locations. Maximum aluminum P90 values for the NorthMet Project Proposed Action ranged from a low 165.4 µg/L (SW-002) to a high of 173.7 µg/L ((SW-005 and SW-006). However, Partridge River background levels for the same locations and the modeled NorthMet Project No Action Alternative concentrations are essentially identical, also exceeding the standard. Therefore, the NorthMet Project Proposed Action would not worsen existing conditions relative to aluminum concentrations in the Partridge River.

Table 5.2.6-2 Maximum Modeled Monthly P90 Surface Water Concentrations for the Partridge River within the Vicinity of the Mine Site

Parameter	Stream Standard[1]	Units	SW-002		SW-004a	
			NorthMet Project Proposed Action	NorthMet Project No Action Alternative	NorthMet Project Proposed Action	NorthMet Project No Action Alternative
General						
Chloride	230	mg/L	21.8	21.8	22.8	22.8
Metals Total						
Aluminum	125	µg/L	165.4	165.4	171.7	173.5
Antimony	31	µg/L	1.66	1.66	3.97	1.67
Arsenic	53	µg/L	5.96	5.96	5.61	3.91
Cadmium	1.3 - 2.7[2]	µg/L	0.12	0.12	0.61	0.12
Chromium	11	µg/L	1.77	1.77	1.87	1.86
Cobalt	5	µg/L	0.58	0.58	2.18	0.74
Copper	4.2 - 10.5[2]	µg/L	2.02	2.03	4.28	2.57
Lead	0.97-3.8[2]	µg/L	0.44	0.44	1.28	0.64
Nickel	23.6-58.7	µg/L	2.91	2.91	15.7	2.98
Selenium	5	µg/L	0.61	0.61	1.27	0.61
Silver	1	µg/L	0.12	0.12	0.14	0.12
Thallium	0.56	µg/L	0.27	0.27	0.22	0.21
Zinc	54.2-135[2]	µg/L	26.0	26.0	33.5	27.4

Source: NorthMet Mining Project and Land Exchange PSDEIS Section 5.2.2.

1 Some stream standards vary with hardness.
2 Range of P10 to P90 standard associated with varying hardness; applicable standard varies with modeled or measured hardness at evaluation location.

Note: Color-highlighted numbers show exceedances at the P90 modeled concentrations.

Colby Lake

As discussed in Section 5.2.2 and exhibited in Table 5.2.6-3, Colby Lake would exceed the evaluation criteria for aluminum under the NorthMet Project Proposed Action. Comparing these evaluation criteria exceedences to the NorthMet Project No Action Alternative indicates no effects to aquatic species would result from the NorthMet Project Proposed Action, as modeled values are very similar under the NorthMet Project No Action Alternative scenario.

Table 5.2.6-3 Maximum Modeled Monthly P90 Surface Water Concentrations for Colby Lake

Parameter	Colby Lake Evaluation Criteria	Units	NorthMet Project No Action Alternative (Max P90 Value)	NorthMet Project Proposed Action (Max P90 Value)
General				
Chloride	230	mg/L	22.7	22.7
Metals Total				
Aluminum	125	µg/L	**173.6**	**173.0**
Antimony	5.5	µg/L	1.65	1.69
Arsenic	2	µg/L	0.65	0.90
Cadmium	5	µg/L	0.12	0.15
Chromium	11	µg/L	1.86	1.87
Cobalt	2.8	µg/L	0.56	0.68
Copper	NA	µg/L	2.09	2.25
Lead	NA	µg/L	0.31	0.38
Nickel	NA	µg/L	2.98	3.94
Selenium	5	µg/L	0.61	0.63
Silver	1	µg/L	0.12	0.12
Thallium	0.28	µg/L	0.05	0.05
Zinc	NA	µg/L	27.5	27.6

Source: Barr 2013c, Mine Site Modeling Results, ver. 5.

Note: Bold font indicated an exceedance of the evaluation criteria.

Mercury concentrations in fish and other aquatic species are an indirect result of mercury loading to aquatic ecosystems from atmospheric and aqueous sources. Inorganic and elemental forms of mercury from atmospheric sources are transformed to methylmercury, which is the predominant form of mercury that bioaccumulates in fish tissue, by sulfate-reducing bacteria in anoxic sediments. In addition, because of atmospheric transport, which occurs on regional and global scales, mercury levels in aquatic life are largely influenced by deposition from anthropogenic sources that are not local to the NorthMet Project area.

The NorthMet Project Proposed Action is predicted to result in a net decrease in mercury loadings to the Partridge River from 24.2 to 23.0 gpy primarily as a result of a decrease in natural runoff (with a total mercury concentration of 3.6 ng/L) and a proportional increase in water discharged from the West Pit via the WWTF (with an assumed total mercury concentration of 1.3 ng/L). As discussed above, sulfate concentrations and loadings from the NorthMet Project Proposed Action to the Partridge River are predicted to remain about the same as existing conditions, so the NorthMet Project Proposed Action would not be contributing additional sulfate that could promote mercury methylation.

Special Status Species

There are no federally listed or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the Partridge River (USFWS 2011). There are three special status aquatic species that have not been found in the NorthMet Project area, but suitable habitat is likely to occur and the species could be present, including:

- Quebec emerald dragonfly – RFSS species
- Ebong boghaunter – RFSS species
- Creek heelsplitter mussel – SGCN and RFSS species

Since the NorthMet Project Proposed Action is not predicted to result in any measurable changes in low flows and negligible changes in average flows, no effects on RCI and ACI, and no change in water quality for any of the Class B water quality standards, no effects on aquatic special status species is expected within the Partridge River Watershed.

5.2.6.2.2 Embarrass River Watershed

This section describes the potential effects of the NorthMet Proposed Action on aquatic resources in the Embarrass River Watershed, including effects on physical habitat, riparian and aquatic connectivity, and water quality.

Physical Habitat Effects

The NorthMet Project Proposed Action could potentially affect flows in the three tributary streams draining the Tailings Basin (i.e., Mud Lake Creek, Trimble Creek, and Unnamed Creek) and flow in the Embarrass River downstream of these tributary effects (i.e., PM-13) (Figure 5.2.6-2). As discussed in Section 5.2.2, PolyMet proposes to capture nearly all seepage from the Tailings Basin, and to mitigate this effect by augmenting flows to the three Embarrass River tributary streams (and Second Creek in the Partridge River) with WWTP effluent and/or Colby Lake water to maintain average annual flows in these tributaries within 20 percent of existing conditions (Table 5.2.6-4). This tributary streams flow augmentation would result in only about a 2.5 percent reduction in average annual flow at PM-13 in the Embarrass River. Changes in average annual flow of this magnitude (< 20 percent) would fall into the range of annual natural variability in terms of precipitation and are not anticipated to result in any measurable impact to available aquatic habitat in the tributary streams or the Embarrass River (PolyMet 2013b).

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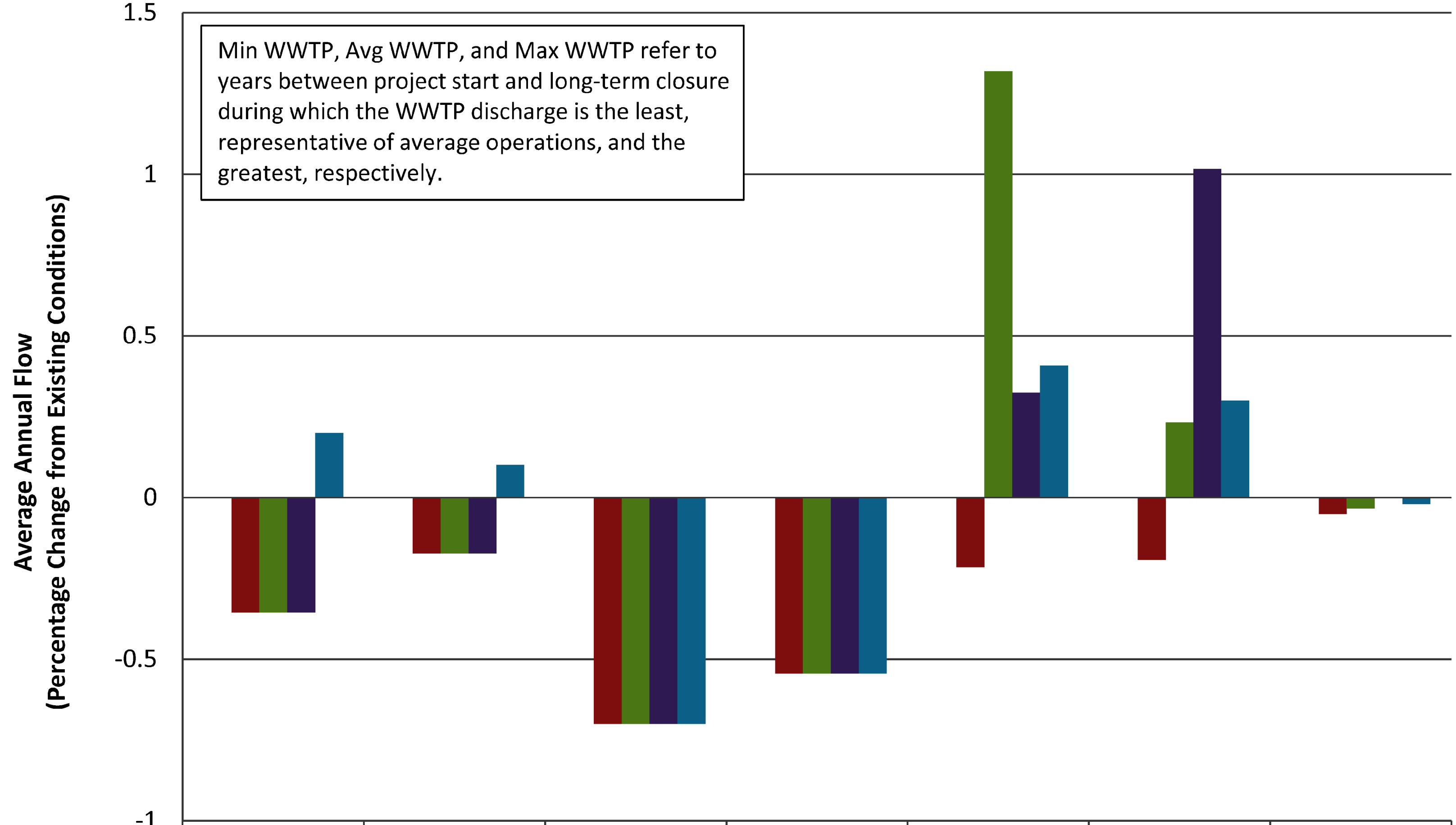
Average Annual Flow at Embarrass River Evaluation Locations



	MLC-3	MLC-2	TC-1	PM-19	UC-1a	PM-11	PM-13
Existing Conditions	0	0	0	0	0	0	0
Project (min WWTP)	-0.355648245	-0.172571192	-0.701217634	-0.543904453	-0.21662751	-0.19211689	-0.052515344
Project (avg WWTP)	-0.355648245	-0.172571192	-0.701217634	-0.543904453	1.319998543	0.232531708	-0.033659039
Project (max WWTP)	-0.355648245	-0.172571192	-0.701217634	-0.543904453	0.32333041	1.016358945	0.00114641
Long-term Closure	0.199912497	0.099300702	-0.701217634	-0.543904453	0.40817423	0.299256924	-0.020551866

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Figure 5.2.6-2
Embarrass River Annual Flow Predictions
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Table 5.2.6-4 Predicted Minimum Flow to the Embarrass River Tributaries

Tributary	Historical Average Annual Flow (gpm)	NorthMet Project Designed Average Annual Flow (gpm)[1]
Mud Lake Creek	665	532
Trimble Creek	1,888	1,510
Unnamed creek	1,180	944
Total	**3,733**	**2,986**

Source: Barr 2013a.

[1] Includes predicted future flow contribution of headwaters watershed.

Water Quality Effects

As described in more detail in Section 5.2.2, the GoldSim water quality model results were screened to compare the single highest monthly P90 water quality prediction from among 2,400 months covered over the 200 year model period with the NorthMet Project No Action Alternative modeled values and the water quality evaluation criteria (Section 5.2.2.1). The screening analysis indicates that the NorthMet Project Proposed Action would meet all Minnesota Class 2 water quality standards and proposed evaluation criteria with the exception of aluminum and lead (Table 5.2.6-5).

The results indicate aluminum would exceed the Class 2B standard (125 µg/L) at all evaluation locations. Maximum aluminum P90 values for the NorthMet Project Proposed Action ranged from a low 151.1 µg/L (TC-1) to a high of 175.9 µg/L (MLC-3). As discussed in Section 5.2.2, however, the predicted increases in aluminum are not the result of increased aluminum loadings from the NorthMet Project Proposed Action, but rather the result of capturing Tailings Basin seepage (via the groundwater containment system) with low concentrations of aluminum, which tends to dilute higher aluminum concentrations in ambient groundwater and surface water, and replacing it, at least partially, with higher aluminum concentration Colby Lake water.

Maximum lead P90 concentrations may exceed the Class 2 water quality standard, which is hardness-based, in Unnamed Creek and Trimble Creek. As discussed in Section 5.2.2, the groundwater containment system would capture virtually all of the high-hardness seepage from the Tailings Basin and would replace it with lower-hardness effluent from the WWTP. This reduction in hardness results in a decrease in the water quality standard. The NorthMet Project Proposed Action would not increase the lead loadings to the receiving streams.

The NorthMet Project Proposed Action is predicted to result in a net increase in mercury loadings to the Embarrass River from 22.5 to 22.9 gpy. This is primarily attributable to the redirection of flow associated with the construction of the East Dam as part of the Tailings Basin expansion to the Embarrass River. If the mercury load associated with this redirection is removed, the NorthMet Project Proposed Action would result in a net decrease in NorthMet Project Proposed Action -related mercury load to the Embarrass River. Further, as described above, the NorthMet Project Proposed Action would result in a 31 percent reduction in sulfate loads at PM-13, so the NorthMet Project Proposed Action would be reducing the potential for mercury methylation, which is the form of mercury that is available for uptake by fish. Therefore, the NorthMet Project Proposed Action would not increase, and could decrease, mercury content in fish by reducing sulfate available for mercury methylation.

Table 5.2.6-5 NorthMet Project Proposed Action and No Action Alternative Maximum Monthly Modeled P90 Surface Water Concentrations for the Embarrass River Watershed within the Vicinity of the Plant Site

			PM-13		**PM-11**		**PM-19**		**MLC-2**	
Parameter	**Stream Standard[1]**	**Units**	**NorthMet Project Proposed Action**	**NorthMet Project No Action Alternative**	**NorthMet Project Proposed Action**	**NorthMet Project No Action Alternative**	**NorthMet Project Proposed Action**	**NorthMet Project No Action Alternative**	**NorthMet Project Proposed Action**	**NorthMet Project No Action Alternative**
General										
Chloride	230	mg/L	9.88	12.2	8.97	22.8	8.01	22.5	10,365	19,219
Metals Total										
Aluminum	125	µg/L	**166.7**	**165.6**	**160.8**	**142.8**	**151.5**	**126.8**	**173.0**	**155.5**
Antimony	31	µg/L	7.83	0.29	18.8	0.31	18.5	0.31	1.45	0.31
Arsenic	53	µg/L	5.25	1.82	10.00	2.39	9.80	3.56	3.45	3.78
Cadmium	1.4 – 9.03[2]	µg/L	0.95	0.13	1.99	0.18	1.94	0.16	0.20	0.15
Chromium	11	µg/L	3.96	2.21	7.97	1.96	7.78	1.77	2.31	2.11
Cobalt	5	µg/L	2.62	1.58	5.00	4.27	4.91	3.07	1.82	1.80
Copper	5.018 – 38.4[2]	µg/L	5.66	2.72	9.00	4.05	8.86	3.22	4.31	2.62
Lead	1.32 – 26.2[2]	µg/L	**1.60**	0.75	**3.00**	0.69	**2.94**	1.02	**1.34**	1.16
Nickel	29.1 – 211.6[2]	µg/L	26.4	4.50	50.0	7.21	49.0	5.37	15.6	4.14
Selenium	5	µg/L	2.69	1.26	4.99	1.09	4.88	1.01	1.30	1.23
Silver	1	µg/L	0.14	0.13	0.21	0.14	0.21	0.13	0.13	0.13
Sodium	NA	µg/L	14,730	37,121	3,247	61,286	5,561	66,871	22,172	59,747
Thallium	0.56	µg/L	0.25	0.25	0.24	0.23	0.23	0.22	0.26	0.25
Zinc	66.9 – 221.2[2]	µg/L	55.9	17.8	100.0	15.4	97.9	15.26	21.5	17.9

Source: NorthMet Mining Project and Land Exchange PSDEIS, Section 5.2.2.

1 Some stream standards vary with hardness.
2 Range associated with varying hardness; exact numbers vary with modeled hardness at evaluation location.
Note: Color-highlighted numbers show exceedances at the P90 modeled concentrations.

Special Status Species

There are no federally listed or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the Embarrass River (USFWS 2011). There are three special status aquatic species that have not been found in the NorthMet Project area, but suitable habitat is likely to occur and the species could be present, including:

- Quebec emerald dragonfly – RFSS species
- Ebong boghaunter – RFSS species
- Creek heelsplitter mussel – SGCN and RFSS species

Since the NorthMet Project Proposed Action is not predicted to result in any measurable changes in low flows and negligible changes in average flows, no effects on RCI and ACI, and no change in water quality for any of the Class B water quality standards, no impacts to aquatic special status species is expected within the Embarrass River Watershed.

5.2.6.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, fish and other aquatic life would be exposed to the water quality and hydrologic and physical habitat conditions that currently exist, which have been historically influenced by past mining activities. Under the NorthMet Project No Action Alternative, aluminum is predicted to remain elevated as compared to current conditions and would exceed the Class 2B water quality standards.

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5.2.7 Air Quality

This section assesses the effects of the NorthMet Project Proposed Action on air quality. Procedures for air quality assessments vary depending upon the level of emissions from a proposed project. The USEPA defines sources as “major” or “minor,” depending on their emissions levels of regulated pollutants (250 tpy of any criteria pollutant, 100,000 tpy of GHGs, 10 tpy of a single HAP, or 25 tpy of all HAPs). As presented in this section, the NorthMet Project Proposed Action has been defined as a minor source according to this definition. However, at the request of several state and federal agencies, much of the analyses were conducted to address requirements for major sources. Discussions of the air quality assessment methodologies, air quality effects, and potential mitigation measures are addressed for criteria pollutants, air toxics, and amphibole fibers.

Summary

The NorthMet Project Proposed Action has been designed so that it is considered a minor source for air permitting purposes. However, the evaluation of the project in this SDEIS has treated it as a major source due to the sensitive nature of the project. Compliance with state and federal ambient air quality standards and growth increments, designed to protect human health and the environment, were evaluated using generally accepted state and federal threshold criteria. The NorthMet Project Proposed Action has been shown to not cause or contribute to significant air quality effects. Local and regional effects, up to 300 km from the project facilities, were evaluated to incorporate federally sensitive, pristine area resources such as BWCAW and Voyageurs National Park. Effects of dust from mining and ore transport are generally confined to areas disturbed by project activities. BACTs were evaluated and applied to the project equipment in order to minimize the potential for air emissions. In particular, BACT-like controls were incorporated to reduce mercury emissions to levels that would not impede current State of Minnesota mercury emissions reduction goals. BACT-like fine-particulate matter emission controls were also incorporated to specifically control the release of more than 99.9 percent of amphibole fibers in the ore.

5.2.7.1 Methodology and Evaluation Criteria

The following subsections describe the air quality standards used in the assessments, local and federal regulations that affect the NorthMet Project Proposed Action, and modeling methodologies and specific modeling assessments conducted, as well as the criteria used to define significant effects from operation of the NorthMet Project Proposed Action.

5.2.7.1.1 Regulatory Setting

Air Quality Standards

The USEPA has established NAAQS for seven criteria air pollutants including NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$, and 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.

The MPCA has also promulgated ambient air standards for the State of Minnesota, known as the MAAQS. In addition to the criteria pollutants, the MAAQS contain standards for TSP and H_2S.

As with the NAAQS, the MAAQS 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.

The NAAQS and MAAQS are summarized in Table 5.2.7-1.

Table 5.2.7-1 Summary of NAAQS and MAAQS

Pollutant	Averaging Period	Standard Value (ppm)	Standard Value (µg/m³)	Standard Type[1]	Notes
Carbon Monoxide	1-Hour	35	40	Primary	Not to be exceeded more than once per year
	1-Hour[2]	30	35	Primary	
	8-Hour	9	10	Primary and Secondary	
Nitrogen Dioxide	Annual Arithmetic Mean	0.05	100	Primary and Secondary	Not to be exceeded
	1-Hour	0.10	188	Primary	Not to Exceed the 98th Percentile of the Maximum Daily 1-hour Values Averaged Over a 3-year Period
Ozone	8-Hour	0.075	147	Primary and Secondary	Daily maximum 8-hour average
Lead	Quarterly		0.15	Primary and Secondary	Rolling 3-month Average
Total Suspended Particulate (TSP)[2]	Annual Geometric Mean		75 60	Primary Secondary	Not to be exceeded
	24-Hour		260 150	Primary Secondary	Not to be exceeded more than once per year
PM_{10}	Annual Arithmetic Mean[2]		50	Primary and Secondary	Not to be exceeded
	24-Hour		150	Primary and Secondary	Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$	Annual Arithmetic Mean		12	Primary and Secondary	Not to exceed the 3-year average of the weighted annual mean concentrations
	24-Hour		35	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 0.02	80 60	Primary Secondary[2]	Not to be exceeded
	24-Hour	0.14	365	Primary and Secondary	Not to be exceeded more than once per

Pollutant	Averaging Period	Standard Value (ppm)	Standard Value (µg/m^3)	Standard Type[1]	Notes
	3-Hour	0.5	1,300	Primary and Secondary	year
	3-Hour[2]	0.35	915	Secondary	
	1-Hour[2]	0.5	1,300	Primary	
	1-Hour	0.075	196	Primary	Not to Exceed the 99th Percentile of the Maximum Daily 1-hour Values Averaged Over a 3-year Period
Hydrogen Sulfide[2]	½-Hour	0.05	70	Primary	Not to be exceeded over 2 times per year
	½-Hour	0.03	42	Primary	Not to be exceeded over 2 times in any 5 consecutive days

Source: MPCA 2013; USEPA 2013.

1 Primary standards set limits to protect human health; secondary standards set limits to protect public welfare.
2 MAAQS only.

Federal Regulations

Attainment Status

Under the CAA, the USEPA has defined all areas within the United States as one of two classifications, attainment or non-attainment. “Attainment areas” are those areas that either have collected ambient air quality data to demonstrate that they are in compliance or they do not have demonstrated non-compliance with the NAAQS, and so they are known as “unclassified areas.” An area that does not meet NAAQS is considered to be a “nonattainment area” for that pollutant, and the USEPA requires the state to develop state implementation plans to control existing and future emissions in order to bring the area into compliance with the NAAQS. The NorthMet Project area has been designated by the USEPA as attainment for all air quality pollutants.

Prevention of Significant Deterioration Review

Under the CAA, the federal PSD requirements provide 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 review includes the following:

- BACT demonstration;
- ambient air quality analysis to assess potential project effects with NAAQS and PSD increments;
- an assessment of Air Quality Related Value (AQRV) of the direct and indirect effects of a 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 USEPA's PSD program allows all attainment areas various levels of air quality protection and growth depending upon its designated class. Class I areas are special areas of natural wonder and scenic beauty—such as national parks, national monuments, and wilderness areas—where air quality should be given special protection. Class II areas are non-Class I areas that are allowed moderate growth and air quality degradation with Class II incremental limits. Class III areas are all non-Class I areas that are deemed unclassified and allow maximum growth and air quality degradation with no incremental limits. For attainment areas, the USEPA has promulgated PSD increments for four pollutants (NO_2, SO_2, PM_{10}, and $PM_{2.5}$) for both Class I and Class II regions. 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. Class II PSD increments are designed to allow further growth within the rest of the country. Table 5.2.7-2 provides a summary of the Class I and Class II PSD increments.

Table 5.2.7-2 Summary of Allowable Prevention of Significant Deterioration Class I and Class II Increments

Pollutant, Averaging Period	Allowable Increment (μg/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
$PM_{2.5}$, 24-hour	2	9
$PM_{2.5}$, Annual	1	4

The NorthMet Project area is located within a Class II attainment area, as designated by the USEPA. In relation to the NorthMet Project Proposed Action, the federal CAA defines a source as a major source in an attainment area if it has any criteria pollutant emissions above 250 tpy or 100,000 tpy of GHG emissions. Because the NorthMet Project Proposed Action is proposing to limit its actual emissions below "major source" thresholds for the federal PSD program, the NorthMet Project Proposed Action is not subject to PSD requirements and, thus, modeling of PSD increment consumption requirements do not specifically apply for permitting. For the purposes of this SDEIS, NorthMet Project Proposed Action effects have been compared to the PSD Class I (generally pristine areas) and Class II (remaining areas) increments, as requested by several agencies, to ensure that the NorthMet Project Proposed Action is not contributing to any significant air quality effects.

Air Quality Related Values

In addition to PSD increments, major PSD sources that are located within 186 miles (300 km) of a Class I area may be required by the FLM to evaluate effects on AQRVs, which may include flora/fauna, visibility, water quality, soils, and odor for a specific Class I area. The NorthMet Project area is within 186 miles (300 km) of four Class I areas: BWCAW and Rainbow Lakes Wilderness (administered by the USFS) and Voyageurs National Park and Isle Royale National Park (under the administration of the National Park Service). Although the NorthMet Project Proposed Action is agreeing to emission limits to avoid being a major PSD source, an evaluation of the applicable AQRV was conducted for comparison in this SDEIS. Table 5.2.7-3 provides the distances to each Class I area from the NorthMet Project area.

Table 5.2.7-3 NorthMet Project Setting Relative to Class I Regions

Class I Region	Distance from NorthMet Project Area (km/mi)
BWCAW	34/21
Voyageurs National Park	82/51
Rainbow Lakes Wilderness	142/88
Isle Royale National Park	218/135

New Source Performance Standards

The federal 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 apply to the NorthMet Project Proposed Action; these could vary depending on the final assessment of the permit application by the MPCA:

- Subpart A – General Provisions, which provides for general notification, recordkeeping, 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 a Class I or Class II region is designated as a nonattainment area or as a maintenance area. Since the NorthMet Project area is classified as in attainment for all criteria pollutants, a General Conformity Determination is not required.

State of Minnesota Regulations

Nonferrous Mineland Reclamation rules, *Minnesota Rules* part 6132.800, administered by the MDNR, 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 are evaluated for the NorthMet Project Proposed Action.

Prevention of Significant Deterioration Review

Minnesota Rules, part 7007.3000, incorporate by reference the federal PSD requirements that provide 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 NorthMet Project Proposed Action is designed to limit emissions below major source thresholds (i.e., to be permitted as a synthetic minor source). Thus, for permitting purposes, the NorthMet Project Proposed Action 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, as stated earlier, a comprehensive analysis of NAAQS, MAAQS, PSD Class I and II increments, and AQRV was performed as part of the evaluation of effect. An evaluation of pollution control technology was conducted for the Mine Site and Plant Site (RS58A, Barr 2007, Draft 02; RS58B, Barr 2007; Barr 2011; Barr 2012).

Minnesota Standards of Performance

A comprehensive list of Minnesota Standards of Performance would be identified in the air quality permit. The following is a list of Minnesota Standards of Performance applicable to the NorthMet Project Proposed Action. This list may change, depending upon the final assessment of the permit application by the MPCA.

Control of Fugitive PM (*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 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 NorthMet Project area (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 0.25 mile from any residence or public roadway), the required control equipment efficiency standard would be 85 percent.

Standards of Performance for Existing Indirect Heating Equipment (*Minnesota Rules*, part 7011.0510). The rule limits the PM emissions to between 0.4 and 0.6 lb/MMBTU, limits SO_2 emissions to between 1.6 and 4.0 lb/MMBTU, and limits opacity to 20 percent. This may apply to existing indirect heaters if used in the mining and processing operations.

Standards of Performance for New Indirect Heating Equipment (*Minnesota Rules*, part 7011.0515). The rule limits emissions of PM to between 0.1 and 0.4 lb/MMBTU, SO_2 emissions to between 0.8 and 4.0 lb/MMBTU, NO_x emissions to between 0.2 to 0.7 lb/MMBTU, and opacity to 20 percent. This may apply to new indirect heaters that may be used in the mine processing operations.

Standards of Performance for Fossil-Fuel-Burning Direct Heating Equipment (*Minnesota Rules*, part 7011.0610). The rule limits PM emissions based upon process throughput and limits opacity to 20 percent. This may apply to process heaters that may be used in the mine processing operations.

Standards of Performance for Pre-1969 Industrial Process Equipment (*Minnesota Rules*, part 7011.0710). The rule limits mass PM emissions based upon process weight and limits opacity to 20 percent. Alternatively, due to the remote location of the NorthMet Project area, compliance can be demonstrated with a pollution control equipment efficiency of 85 percent. This may apply to existing ore-handling equipment that may be used in the mine processing operations.

Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (*Minnesota Rules*, part 7011.3520). The rule incorporates federal Standards of Performance for Stationary Compression Ignition Internal Combustion Engines under 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 NESHAP under 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.

5.2.7.1.2 Evaluation Criteria

Various state and federal air quality standards and emissions standards have been established to minimize degradation of air quality. The criteria used for the evaluation of potential effects on air quality from the NorthMet Project Proposed Action or an alternative are whether it would cause an exceedance of NAAQS or MAAQS.

In addition to legally applicable statutory or regulatory requirements, the following criteria also were considered in evaluating effects from the NorthMet Project Proposed Action:

- consumption of PSD increments as defined by the CAA Title I, PSD rule;
- adverse effects to visibility in Class I areas;
- adverse effects to other AQRV in Class I areas; and
- adverse effects to human health as determined by an AERA (MPCA 2013b).

5.2.7.1.3 Proposed Action Emissions

From an air quality perspective, emissions from the NorthMet Project Proposed Action 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 three components constitute 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, use of 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 travel over unpaved roads from the excavation site to the rail loading and stockpiling areas. Fugitive emissions would be generated as part of these operations. In order to minimize fugitive emissions, the NorthMet Project Proposed Action will utilize several control measures. These include minimization of drop distances for ore-screening, truck loading/unloading, and rail-loading; water and other dust suppressants on haul roads (90 percent control); water sprays for rock crushing and screening; down-hole watering during blasting operations; and environmental observations and recording. In addition, two ambient air quality monitors are proposed to minimize fugitive dust effects at the mine.

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, and combustion. In addition, fugitive emissions are expected to occur from raw materials handling, Plant Site roads, the Tailings Basin, and from vehicle use of Dunka Road. Water spraying or other dust suppression would be used on all unpaved roads at the Plant Site, resulting in an 80 percent reduction in associated fugitive emissions.

PolyMet is proposing to accept emission limits below the major source threshold (stationary sources less than 250 tpy for criteria pollutants and 100,000 tpy for GHGs) so as to be classified as a synthetic minor PSD source and therefore not be subject to PSD requirements including modeling attainment with PSD increments for permitting purposes. As demonstrated in Table 5.2.7-4, below, the NorthMet Project Proposed Action does not have projected actual emissions above major PSD thresholds on an annual basis. PSD required modeling analyses, however, were performed for this SDEIS to assess its effect to ensure that the minor-source NorthMet Project Proposed Action does not cause or contribute to significant effects.

Criteria Pollutants

Criteria pollutant emissions are expected from both the Mine Site and Plant Site. Detailed information on the emission calculations for each site source is available as separate documents (Barr 2012a; Barr 2013). Table 5.2.7-4 summarizes the NorthMet Project Proposed Action maximum emissions for the Mine Site, Plant Site, and total emissions from PSD-regulated stationary sources for comparison with PSD Major Source Thresholds.

Table 5.2.7-4 Annual Criteria Air Pollutant Emissions for Prevention of Significant Deterioration-regulated Stationary Sources

Pollutant	Plant Site Projected Actual Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)	PSD Major Source Thresholds (tpy)
NO_x	117	5	122	250
SO_2	7	0.8	8	250
TSP	201	9	210	250
PM_{10}	192	4	196	250
$PM_{2.5}$	190	2	192	250
VOC	50	0.2	50	250
Pb	0.0	0.0	0.0	250
CO	127	2	129	250

In accordance with PSD permitting requirements, for this assessment, mobile emissions and fugitive emissions sources are not included in the determination of a major source. Under PSD requirements, fugitive sources are only included if the stationary source is defined as one of 28 named source categories. The NorthMet Project Proposed Action is not included in any of the USEPA-listed source categories; therefore, fugitive sources are not included in the determination of a major source. However, to assess modeled air effects, mobile and fugitive emissions from the operations were evaluated. The mobile source emissions and fugitive emissions are summed in Table 5.2.7-5. Due to the size of the ore rock being transported, the design of the railcars, and the short distance of transport from the Mine Site to the Plant Site, the ore fines are expected to be coarse in nature. Thus, no significant reactive airborne fugitive dust from the rail transport is expected (MDNR 2011) and is not included in the fugitive emissions. Any spillage of the ore fines is expected to be within 2 meters of the rail line, along the path, and any effects of the reactive ore on the ground has been addressed in Section 5.2.3.

Table 5.2.7-5 Annual Air Pollutant Emissions for Mobile Sources and Fugitive Sources

Pollutant	Plant Site Projected Actual Emissions (tpy)	Mine Site Projected Actual Emissions (tpy)	Total Projected Actual Emissions (tpy)
NO_x	58	321	379
SO_2	0	2	2
PM_{10}	238	462	700
$PM_{2.5}$	31	77	108

Hazardous Air Pollutants Emissions

Small amounts of potentially toxic compounds, which are referred to as HAPs, are expected to be associated with the NorthMet Project Proposed Action. Table 5.2.7-6 provides the estimate of HAP emissions for the NorthMet Project Proposed Action stationary sources. These emission levels reflect potential emissions taking into account the proposed pollution control equipment for the NorthMet Project Proposed Action (controlled). As seen on the table, total emissions of a single HAP are 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 HAPs. Although HAP emissions from mobile sources were not included in the table to address emission thresholds, these emissions were used in assessing the potential effects on human health. The AERA itself is not limited to an assessment of HAPs, but is inclusive of any air toxic pollutant that screened in during the scoping process.

Table 5.2.7-6 Annual Hazardous Air Pollutant Emissions for Prevention of Significant Deterioration-regulated Stationary Sources

Pollutant	Plant Site Projected Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)	Major Source Threshold (tpy)
Single HAP[1]	7	0.1	7	10
Combined HAPs	14	0.1	14	25

1 Nickel is the HAP with the highest emissions for the Plant Site, manganese has the highest emissions at the Mine Site. Highest single HAP emissions for the Proposed Action are the nickel emissions. Values in Table 5.2.7-7 reflect nickel emissions.

Greenhouse Gas Emissions

Direct and indirect GHGs emissions would be associated with the NorthMet Project Proposed Action. Direct emissions are emitted from project sources; indirect emissions are from sources that are not part of the project, but are generated from activities that support the project (e.g., off-site electrical needs). These gases include primarily CO_2, N_2O, and CH_4. GHG emissions are estimated based upon their global warming potential and are expressed in CO_2e. Global warming potential is the relative effect a specific compound has on the overall global warming effects. The global warming potential factors for the three pollutants are 1, 298, and 25, respectively. For this assessment, the CO_2e is estimated by multiplying the specific emissions by its global warming potential factor and then summing the results. Table 5.2.7-7 summarizes the controlled direct GHG emissions for the NorthMet Project Proposed Action. As seen from the table, total direct GHG emissions are less than 100,000 tpy of CO_2e and would not exceed the USEPA major source thresholds for GHGs.

Table 5.2.7-7 Annual Greenhouse Gas Emissions for Prevention of Significant Deterioration-regulated Stationary Sources

Pollutant	Plant Site Projected Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)	Major Source Threshold (tpy)
CO_2	75,312	1,740	77,052	-
N_2O	0.9	0.8	1.7	-
CH_2	0.5	0.2	0.7	-
Total CO_2e[1]	**75,615**	**1,764**	**77,379**	**100,000**

1 CO_2e is used to assess PSD applicability.

The total carbon footprint for the NorthMet Project Proposed Action is made up of both direct and indirect GHG emissions. The estimated maximum carbon footprint of the NorthMet Project Proposed Action is based on the NorthMet Project Proposed Action as currently proposed running at maximum capacity (potential). The expected GHG emissions from the NorthMet Project Proposed Action are calculated using The Climate Registry General Reporting Protocol (Climate Registry 2008) and the MPCA General Guidance for Carbon Footprint Development in Environmental Review (MPCA 2008). Emissions are calculated using default emission factors for specific fuels from the two documents. The annualized carbon footprint is summarized in Table 5.2.7-8; the lifetime carbon footprint is provided in Table 5.2.7-9.

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 sources 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).

Table 5.2.7-8 NorthMet Project Proposed Action Annual Greenhouse Gas Emissions

Pollutant	Potential Direct Emissions[1] (CO_2e – mtpy)[2]	Potential Indirect Emissions (CO_2e – mtpy)	Potential Total Emissions (CO_2e – mtpy)
Mine Site Point Source	1,600		
Mine Site Mobile Source	38,086		
Plant Site Point Source	138,641		
Plant Site Mobile Source	8,014		
Totals	**186,342**	**511,000**	**697,342**

1 Maximum Potential Direct Emissions are all emissions from sources that are under direct control of the NorthMet Project Proposed Action and full maximum capacity.
2 CO_2e is in metric tons per year (mtpy).

Table 5.2.7-9 NorthMet Project Proposed Action Lifetime Greenhouse Gas Emissions

Pollutant	Potential Direct Emissions[1] (CO_2e – mtpy)[2]	Potential Indirect Emissions (CO_2e – mtpy)[6]	Potential Total Emissions (CO_2e – mtpy)
Mine Site Emissions[3]	793,734		
Plant Site Emissions[3]	2,933,181		
Construction Emissions[4]	94,186		
Reclamation Emission[5]	1,549,688		
Subtotals	**5,370,789**	**10,220,000**	**15,590,789**
Terrestrial Carbon Loss[7]	199,963	-	199,963
Totals	**5,570,752**	**10,220,000**	**15,790,752**

1 Maximum Potential Direct Emissions are all emissions from sources that are under direct control of the NorthMet Project Proposed Action and full maximum capacity.
2 CO_2e is in mtpy.
3 Based upon maximum annual emissions occurring for 20 years.
4 Includes Phase I (flotation concentration production only) and Phase II (Hydrometallurgical Plant) construction.
5 Based on 20-year closure period for Plant Site and 60-year closure period for Mine Site.
6 Indirect emissions: Emissions that are a consequence of the activities of the reporting entity, but that occur at sources owned or controlled by another entity.
7 Terrestrial carbon loss includes: wetland carbon loss, 20 years of emissions from stockpiled peat, and emission from peat used in reclamation.

5.2.7.1.4 Predictive Modeling Approach

Detailed air dispersion modeling was conducted to evaluate compliance with NAAQS and MAAQS, to support PSD increment analysis, and to identify other potential effects on Class I and Class II areas. Although the NorthMet Project Proposed Action is not considered a major source for PSD considerations, the modeling analysis was conducted pursuant to the PSD regulations. The methods used for modeling are summarized below.

NAAQS, MAAQS, and Class II Increment Modeling Approach

To assess the effects on air quality, air dispersion modeling techniques were utilized. The MPCA prefers the AERMOD modeling system, and USEPA has included AERMOD as an approved guideline model. Meteorological data (2006 to 2010) from the Hibbing station and concurrent International Falls mixing height data, suitable for input to AERMOD, were used to evaluate the NorthMet Project Proposed Action. The AERMINUTE meteorological processor was used to develop the meteorological dataset for AERMOD. The meteorological dataset was modified to allow wind speeds less than 0.5 m/s to be defined as calm conditions in AERMOD by substituting all wind speeds less than 0.5 m/s to 0.0 m/s.

The air quality modeling addressed individual point sources, as well as all sources of fugitive particulate matter. The modeling was conducted to determine the extent of effects from criteria pollutant emissions on ambient air quality and to identify the SIA for each pollutant. Modeling was conducted for PM_{10}, $PM_{2.5}$, NO_2, and SO_2 and their respective applicable averaging times at both the Mine Site and Plant Site (Barr 2012c; Barr 2012d). 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 NorthMet Project Proposed Action would not result in appreciable lead emissions. CO 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.

NorthMet Project Proposed Action emissions were initially modeled and compared to their respective SIL, as provided in Table 5.2.7-10 for each of the pollutants and averaging times. The SIL is the threshold for a given pollutant and averaging time, where no further modeling analysis is required. Modeled emissions above the SIL do not define a significant effect in the context of the EIS; rather, where the modeled emissions are above the SIL, more refined modeling is required in order to evaluate compliance with PSD increments and NAAQS. The farthest distance from the source where the concentration is above the SIL defines the circular region that would require further affect modeling.

All point and fugitive sources associated with the Mine Site and Plant Site were included in the source input files for PSD Class II 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 increment-expanding) sources, which were determined and provided by the MPCA, were also included as source input:

- Northshore Mine;
- Mesabi Nugget Phase 1 Project;

- Cliffs Erie pellet yard; and
- Former LTVSMC processing plant.

Model inputs for these sources were provided by the MPCA. For comparison to the NAAQS, a background concentration was added to the modeled concentration. PM_{10} background concentrations represent the 2008 to 2010, 3-year average concentrations for the high-second-high 24-hour concentration and maximum annual average concentration from the Virginia, Minnesota air quality monitoring site. $PM_{2.5}$ background concentrations represent the 2008-2010 average concentrations for the highest 2nd high (H2H) 24-hour and annual average concentrations from the same station. Hourly SO_2 and NO_2 background concentrations are from 2010 MPCA update data for use in modeling assessments (MPCA 2012) for sites outside Minneapolis.

<u>Class I Area-Related Modeling Approach</u>

An air quality modeling analysis was conducted to estimate effects of the NorthMet Project Proposed Action 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 is addressed in Section 6.7.6. The dispersion modeling analysis used standard USEPA long-range transport modeling methodologies and followed guidance as presented in: 1) USEPA's Guideline on Air Quality Models, the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 report; 2) the Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I report (revised November 2010); and 3) the "FLM Recommendations on Class I Area Analyses" (Barr 2012). The analyses also incorporated suggestions and guidance received from the USFS and the National Park Service. The California Puff (CALPUFF) air quality modeling system (version 5.8, June 23, 2007 release) was used for all Class I area analyses.

Input options and data utilized in the models generally corresponded to default or USEPA-recommended values along with representative, NorthMet Project Proposed Action-specific source input parameters (Barr 2012). The CALPUFF modeling analysis used refined meteorological fields from the CALMET subprogram of CALPUFF, developed from the 5th Generation NCAR/Penn State Mesoscale Model prognostic meteorological data for the available years 2002, 2003, and 2004. These were refined using concurrent surface, upper air, and precipitation data as outlined in the Final SDD. CALMET settings were based on the USEPA Office of Air Quality Planning and Standards memorandum "Clarification on EPA-FLM Recommended Settings for CALMET" (August 31, 2009). Hourly surface data from approximately 88 stations and precipitation data from 99 stations were used along with upper air data from four stations. No cloud data were used.

Pollutant emissions modeled in CALPUFF were SO_2, NO_X, PMC (coarse particulate matter), PMF (fine particulate matter), EC (elemental carbon), SOA (secondary organic aerosols), and SO_4. Additionally, the pollutants SO_4, NO_3, and HNO_3 were modeled as products of the chemical transformation of SO_2 and NO_X. For the AQRV analysis, the MESOPUFF II scheme was used for the chemical mechanism to compute chemical transformation rates based on user-supplied background values for ozone and ammonia. Per MPCA guidance, the MESOPUFF II algorithm and secondary particulate formation were not used in the PM_{10} increment consumption evaluation. Finally, the CALPOST and POSTUTIL post-processing programs were used to generate values of pollutant concentration, deposition, and visibility.

For the increment consumption analysis, emissions were modeled as the worst case over the expected life of the NorthMet Project Proposed Action. For the AQRV analysis, four emissions scenarios, representing emissions at different stages of the NorthMet Project Proposed Action, were modeled. The scenarios differ only in mobile source emissions (which were not included in the increment analysis). The effects of all four scenarios on visibility within the Class I areas are presented in Section 5.2.7.2.1.

5.2.7.2 NorthMet Project Proposed Action

This section describes effects that may occur on local and regional air quality from implementing the NorthMet Project Proposed Action. Potential effects on visibility that could occur from increases in project emissions are also discussed. The results of the modeling are used to represent an upper bound for assessing potential effects from the NorthMet Project Proposed Action.

5.2.7.2.1 NAAQS and Prevention of Significant Deterioration 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. To demonstrate NorthMet Project Proposed Action effects relative to NAAQS and PSD increments, an air dispersion modeling analysis for the NorthMet Project Proposed Action was conducted (Barr 2012c; Barr 2012d; Barr 2012e; Barr 2012f).

Initial Significant Impact Limit Analysis

The Mine Site and Plant Site are located 8 miles apart, but are connected by a private railway that was originally constructed to transport iron ore pellets from Cliffs Erie'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, the Mine Site and Plant Site emission sources are not adjacent to each other but rather separated by a substantial (8 miles) distance. Therefore, it is appropriate and informative to perform individual air dispersion modeling for two distinct sets of receptors, one set surrounding the Mine Site and the second surrounding the Plant Site. 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 effects were below the 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 effect when combined with other nearby source effects. The MPCA approved the exclusion of the Mine Site emissions in assessing the effects at the Plant Site receptor grid locations, as they would not likely contribute to a change in the overall effects. The results are discussed below.

The Plant Site PM_{10} emissions were modeled with all sources operating at full capacity in a single modeling run. This conservatively predicts (overestimates) the effects, as not all sources would be capable of operating simultaneously at full capacity. PM_{10} and $PM_{2.5}$ are the primary pollutants 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 continuously operating fuel combustion sources. The Mine Site emission rates are based on a daily average mining rate of 32,000 tons of ore.

Table 5.2.7-10 shows modeled effects at the Mine Site and Plant Site receptors compared to the SIL. The maximum modeled effects are maximums from either the Mine Site or the Plant Site analyses, since each analysis includes all project emissions, as defined above. The USEPA has developed SILs as a way to screen out, from further PSD analysis, pollutants that are not expected to cause any significant contribution to existing air quality levels. The emissions included are at 100 percent capacity for each averaging period.

The overall effects within the Plant Site receptor grid predicted higher maximum concentrations than the effects within the Mine Site receptor grid for all pollutants modeled. As seen in the table, maximum PM_{10} and $PM_{2.5}$ concentrations in both regions (and for all averaging periods) were above their respective SILs, so further analysis in those regions, for those pollutants, was conducted. For NO_2 and SO_2, the effects in the Plant Site receptor grid exceed their SILs for all averaging periods and additional analysis was conducted for this receptor region. The NO_2 and SO_2 effects in the Mine Site receptor grid are all below each respective SIL, and, thus, no additional analysis was conducted.

Table 5.2.7-10 Highest NorthMet Project Proposed Action Effects and Prevention of Significant Deterioration Class II Significant Impact Limits

Pollutant	Averaging Time	PSD Class II Significant Impact Limits ($\mu g/m^3$)	Plant Site Area Modeled Effects ($\mu g/m^3$)[1]	Mine Site Area Modeled Effects ($\mu g/m^3$)[1]
SO_2	1-hour	7.83	***103***	0.7
	3-hour	25	***85***	0.5
	24-hour	5	***35***	0.1
	Annual	2	***6***	0.01
PM_{10}	24-hour	5	***44***	***30***
	Annual	1	***12***	***6.3***
$PM_{2.5}$	24-hour	1.2	***17***	***10***
	Annual	0.3	***6***	***2.2***
NO_2	1-hour	7.52	***88***	5.3
	Annual	1	***3***	0.1

[1] Bold and italicized values exceed SIL.

Prevention of Significant Deterioration Class II Increment Analysis

Based upon the results of the SIL analysis, PSD Class II increment analyses were completed for PM_{10} for both the Mine Site and Plant Site receptor grid locations. In addition, a PSD Class II increment analysis was conducted for NO_2 and SO_2 only at the Plant Site receptors. Even though maximum $PM_{2.5}$ concentrations exceed the SILs, the baseline date for increment analysis in St. Louis County has not been set. Therefore, no increment analysis can be conducted for this pollutant. However, modeling of $PM_{2.5}$ was conducted for comparison with the $PM_{2.5}$ NAAQS; the results are presented later in this section. The modeling included all NorthMet Project Proposed Action increment-consuming sources at maximum emission rates plus all nearby increment-consuming (and expanding) emissions sources, including the Cliffs Erie pellet yard, the former LTVSMC processing plant, Northshore Mine, and Mesabi Nugget. The results of the increment analyses are shown in Table 5.2.7-11, along with a comparison to the allowable Class II PSD increments.

Table 5.2.7-11 Results of Class II Prevention of Significant Deterioration Increment Analysis

Pollutant	Averaging Time	Plant Site Receptor Grid Modeled Effects ($\mu g/m^3$)(1) (3)	Mine Site Receptor Grid Modeled Effects ($\mu g/m^3$)(1) (3)	PSD Increment Limits ($\mu g/m^3$)
SO_2	3-hour	11	NA	512
	24-hour	1.9	NA	91
	Annual	0.17	NA	20
PM_{10}(2)	24-hour	18	29	30
	Annual	3.0	5	17
NO_2	Annual	0.9	NA	25

1 SO_2 concentrations were not modeled due to negligible incremental effect.
2 Modeled PM_{10} concentrations are based on operating scenarios at year 8 and year 13.
3 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 former LTVSMC processing plant and existing LTVSMC Tailings Basin.

The table displays the maximum predicted concentrations for each pollutant of concern and each averaging period for both the Mine Site and Plant Site receptor grid locations. Since the receptor grid locations for the Mine Site and Plant Site represent separate distinct regions, the maximum modeled effect for each modeling region is compared separately with the PSD Class II increment limit to assess potential significant effects. Overall, all modeled effects are below their respective PSD Class II limits; however, the maximum 24-hour PM_{10} effects in the Mine Site modeling region approach the Class II increment (29 $\mu g/m^3$ versus 30 $\mu g/m^3$).

Mine Site Receptors Analysis

The PM_{10} modeling was conducted for two operating scenarios corresponding to the different Category 1 and Category 2 waste rock disposal operations that would occur over the 20-year life of the mine. The worst case years for disposal of Category 1 and Category 2 waste rock (year 8) and in-pit disposal (year 13) 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 $\mu g/m^3$ for the year 8 operating scenario and 29 $\mu g/m^3$ for the year 13 operating scenario (shown on Table 5.2.7.11). The H2H corresponds to not exceeding a standard more than once per year, as defined by the applicable standard. NO_2 and SO_2 effects from the NorthMet Project Proposed Action at the Mine Site were below the SILs, so no additional modeling including nearby sources was performed.

Plant Site Receptors Analysis

The Plant Site PM_{10} emissions were modeled with all sources operating at full capacity in a single modeling run (independent of operating year). This conservatively predicts (overestimates) the effects, as not all sources would be capable of operating simultaneously at full capacity. The operation at the Plant Site, including fugitive sources, building vents, limestone material handling, and vehicular traffic on paved roads results in a maximum increment concentration for PM_{10} of 18 μg/m^3 on the Plant Site boundary receptor grid, based on the 24-hour H2H modeling. Modeled effects for SO_2 and NO_X at the Plant Site receptors are also below the PSD Class II increments thresholds.

The data in Table 5.2.7-11 summarize the PSD increment modeling results and demonstrate that the NorthMet Project Proposed Action, in conjunction with all other neighboring PSD sources, would satisfy all state and federal increment requirements. The maximum concentrations for the Mine Site receptor grid and the Plant Site receptor grid are presented separately. Since the two receptor grids represent two separate AOCs, the maximum concentrations are not additive.

NAAQS and MAAQS Impact Analysis

The NAAQS modeling predicted the maximum effect of development at the Mine Site and Plant Site combined with activities at other regional sources. The highest total effects modeled, plus background concentrations, are compared to applicable MAAQS and NAAQS. Maximum emission rates were modeled for all NorthMet Project Proposed Action sources and key criteria pollutants (i.e., NO_X, SO_2, PM_{10}, and $PM_{2.5}$).

Table 5.2.7-12 summarizes the results of the NAAQS model analysis for the Mine Site and Plant Site separately. The modeled concentration from either the Mine Site receptors or the Plant Site receptors was added to the ambient background to assess total impact, since, in each area, modeling analysis included the entire NorthMet Project area and nearby sources. The highest 6th high (H6H) PM_{10} concentration for the 5-year modeling period was used for comparison to the NAAQS PM_{10} 24-hour standard. The highest 8th high (H8H) 1-hour NO_2 and 24-hour $PM_{2.5}$ concentration for the 5-year modeling period was used for comparison to the NAAQS NO_2 1-hour standard and the $PM_{2.5}$ 24-hour standard, respectively. The H8H concentration represents the 98th-percentile daily maximum concentrations modeled over a 5-year period, as defined by each standard. The highest 4th high (H4H) 1-hour SO_2 concentration for the 5-year modeling period was used for comparison to the 1-hour SO_2 NAAQS. The H4H concentration represents the 99th-percentile daily maximum 1-hour concentrations modeled over a 5-year period, as defined by the standard. The highest 2nd high 3-hour and 24-hour SO_2 concentrations were used for comparison with the 3-hour and 24-hour SO_2 NAAQS. Maximum annual average concentrations for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ were compared against their respective annual average NAAQS.

Mine Site

The analysis for the Mine Site included potential emissions from the nearby sources included in the NAAQS analysis, specifically Mesabi Nugget, Cliffs Erie Pellet Yard, Northshore Mine, and the Plant Site. The 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 effect on the Mine Site receptor grid (Barr 2012c).

The PM_{10} NAAQS modeling results conservatively added the maximum modeled emissions from the Mine Site and the maximum modeled effect from the other nearby sources to background concentrations for comparison to the NAAQS. Cumulative modeling and further analyses for NO_2 and SO_2 were not performed because the NO_2 and SO_2 concentrations at the Mine Site were shown to be well below the SILs.

The maximum effects from the Mine Site analysis are slightly higher for PM_{10} and slightly lower for $PM_{2.5}$ than the effects from the Plant Site summarized below in Table 5.2.7-12. The maximum predicted annual $PM_{2.5}$ concentration (Mine Site contribution plus background) was 10 $\mu g/m^3$ or approximately 83 percent of the corresponding NAAQS. The maximum predicted 24-hour $PM_{2.5}$ concentration was 32 $\mu g/m^3$ or approximately 91 percent of the short-term $PM_{2.5}$ standard. All other predicted concentrations are at or below 60 percent of the allowable levels, which demonstrates compliance with MAAQS and NAAQS.

Table 5.2.7-12 Results of Class II NAAQS Modeling

Pollutant	Averaging Time	Maximum Modeled – Plant Site ($\mu g/m^3$)[1,2]	Maximum Modeled – Mine Site ($\mu g/m^3$)[1]	Total ($\mu g/m^3$)[2]	NAAQS and MAAQS ($\mu g/m^3$)
SO_2	1-hour	*893*	NA	893	1,300[3]
	1-hour	***893***	NA	***893***	196[4]
	3-hour	*784*	NA	784	915
	24-hour	*255*	NA	255	365
	Annual	*24*	NA	24	60
PM_{10}	24-hour	77	*88*	88	150
	Annual	19	*22*	22	50[5]
$PM_{2.5}$	24-hour	*34*	32	34	35
	Annual	*11*[6]	10	11	12
NO_2	1-hour	***292***	NA	***292***	188[7]
NO_2	Annual	*23*	NA	23	100

1 Maximum concentrations include background.
2 Concentrations exceeding the standard are bolded and italicized.
3 MAAQS for 1-hour SO_2.
4 NAAQS for 1-hour SO_2.
5 The annual NAAQS for PM_{10} was rescinded on October 17, 2006.
6 The maximum modeled Plant Site concentration was calculated as the maximum design value as defined by the USEPA guidance (USEPA 2013).
7 NAAQS for 1-hour NO_2.

Plant Site

The NAAQS modeling on the Plant Site ambient boundary included all Plant Site and nearby sources plus emissions from the Tailings Basin and unpaved roads. Maximum predicted concentrations were added to background values to calculate maximum ambient air concentrations. All predicted concentrations are below allowable levels, and the results demonstrate compliance with all MAAQS and NAAQS, except for the 1-hour NO_2 and 1-hour SO_2 NAAQS. The maximum predicted ambient 1-hour NO_2 concentration was 292 $\mu g/m^3$, which was predicted to occur to the southwest portion of the ambient air quality boundary, and exceeded the 1-hour NO_2 NAAQS (188 $\mu g/m^3$). The Plant Site modeled contribution at the location of maximum effect is 0.002 $\mu g/m^3$. Other receptors where concentrations were lower than the maximum but exceeded the 1-hour NO_2 NAAQS were predicted primarily on the western half of the receptor grid and were due to the nearby sources (see Figure 5.2.7-1). For all receptors that exceeded the 1-hour NO_2 NAAQS, the contributions from the Plant Site sources were less than the 1-hour NO_2 Significance Threshold of 7.5 $\mu g/m^3$ and are considered to have no significant contribution to the predicted exceedances. Similarly, the maximum 1-hour SO_2

ambient concentration was predicted at the southwestern border of the ambient boundary with a value of 893 $\mu g/m^3$ and exceeded the 1-hour SO_2 NAAQS of 196 $\mu g/m^3$ (See Figure 5.2.7-2).

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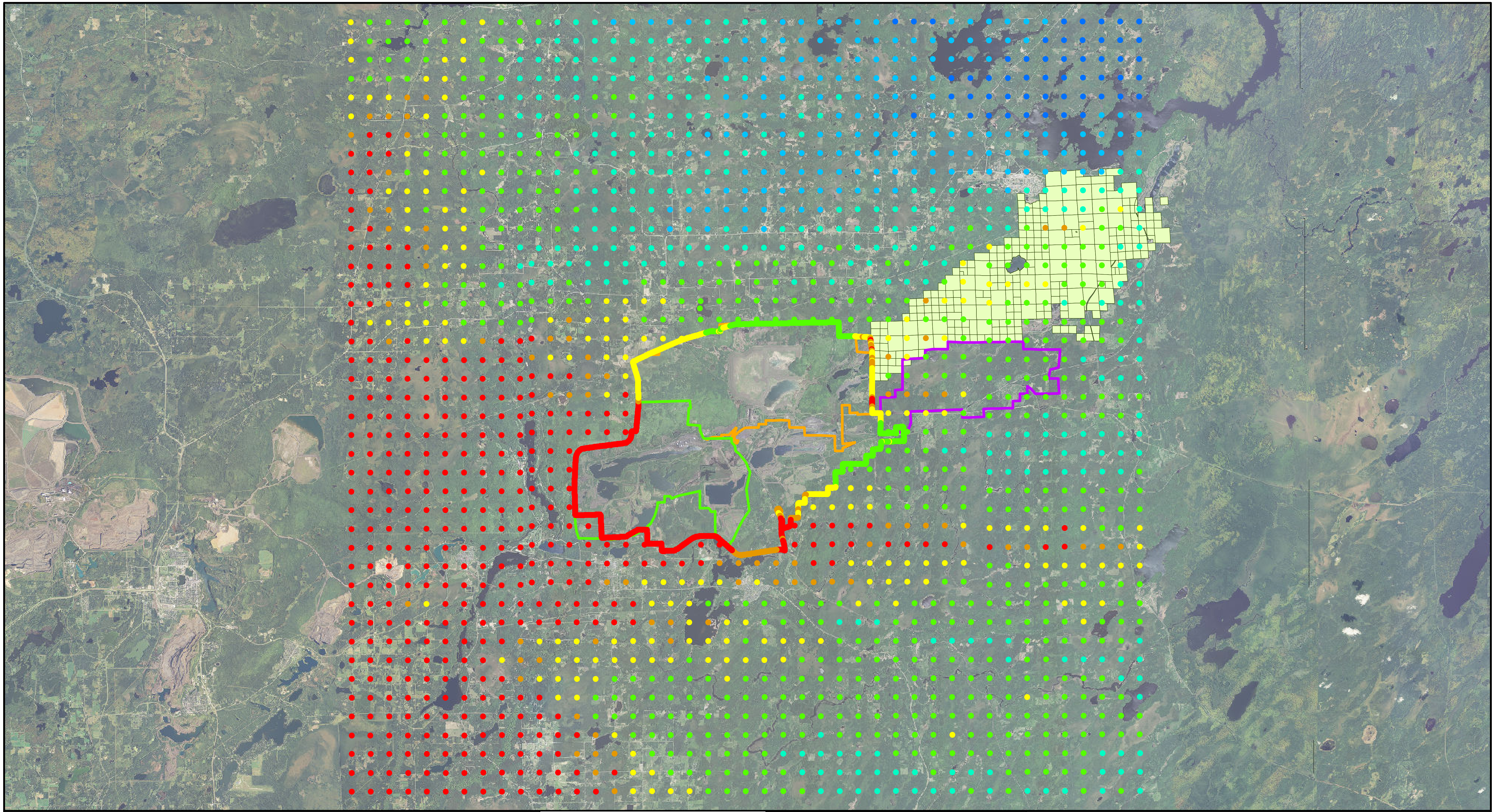

H8H Concentration ug/m

- 142 - 149
- 150 - 159
- 160 - 169
- 170 - 179
- 180 - 185
- 186 - 188
- 189 - 292

Mesabi Nugget Ambient Air Boundary

Mine Site Ambient Air Boundary

Plant Site Ambient Air Boundary

St Louis County Tax Records

Minnesota Department of Natural Resources

US Army Corps of Engineers St. Paul District

Forest Service U S Department of Agriculture

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

N W E S

0 1 2 4 6 Miles

Figure 5.2.7-1
1 Hour NO2 Cumulative Effect NAAQS Results
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

DRAFT SUBJECT TO REVISION

April 2013

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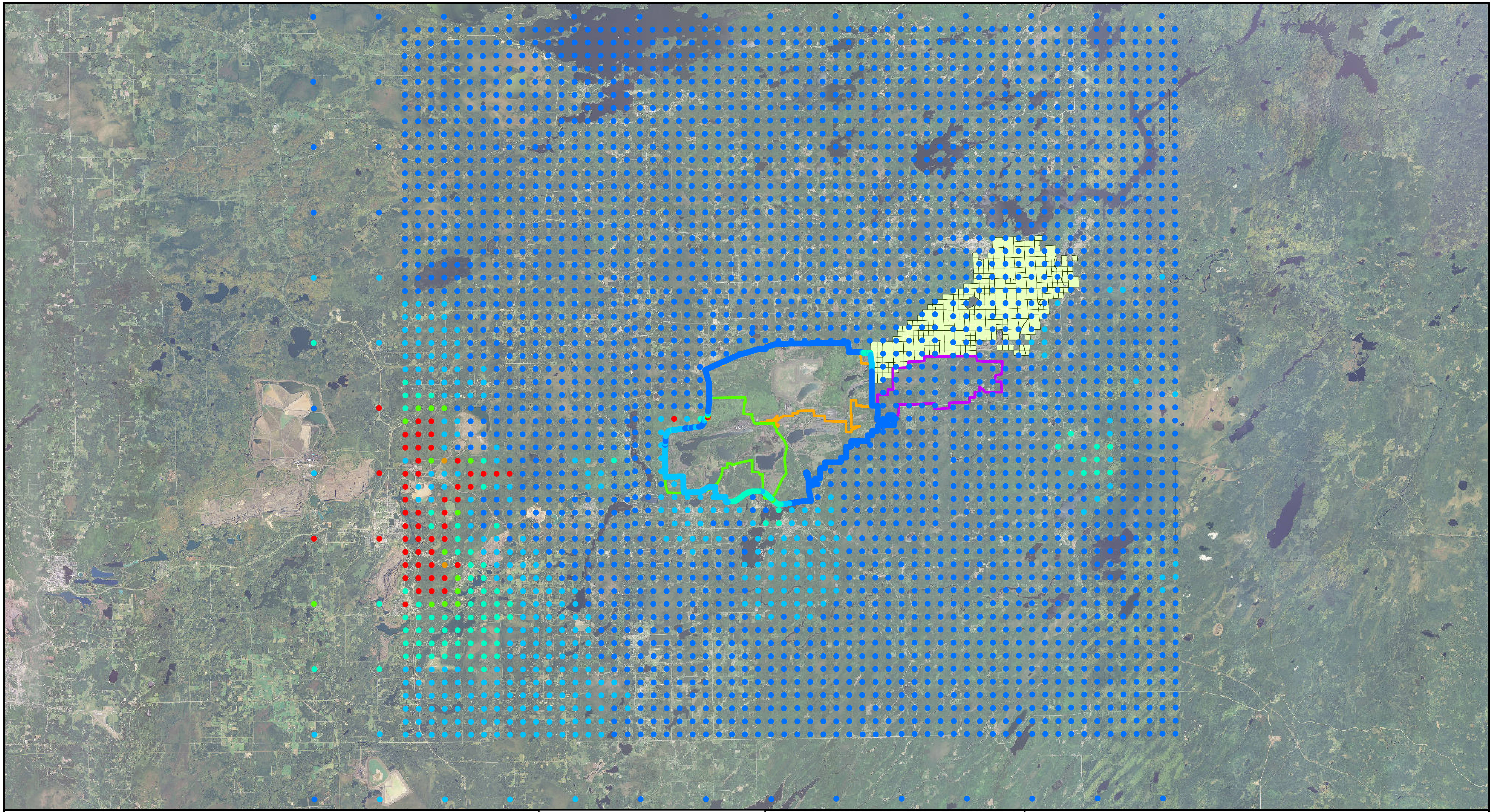

Minnesota DEPARTMENT OF NATURAL RESOURCES

US Army Corps of Engineers St. Paul District

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

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Figure 5.2.7-2
1 Hour SO2 Cumulative Effect NAAQS Results
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

DRAFT SUBJECT TO REVISION

April 2013

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Similarly, the Plant Site maximum modeled contribution to this maximum was 0.002 μg/m^3, well below the 1-hour SO_2 Significance Threshold of 7.8 μg/m^3. For all receptors that exceeded the 1-hour SO_2 NAAQS, the contributions from the Plant Site sources were less than the 1-hour SO_2 Significance Threshold, thus having no significant effect on any predicted exceedances. It should be noted that under federal regulations, the MPCA would be required to address the modeled exceedances prior to permitting a "Major Source." However, since the NorthMet Project Proposed Action is considered a minor source, the federal regulations are not applicable.

5.2.7.2.2 Prevention of Significant Deterioration Class I Modeling Analysis

Modeling analysis was conducted to assess the effects from the emissions of the NorthMet Project Proposed Action in four USEPA-designated Class I areas within the NorthMet Project area. Modeled effects were assessed against the PSD Class I Increment and AQRVs.

Prevention of Significant Deterioration Class I Increment Modeling Results

Maximum pollutant concentrations within the BWCAW, Voyageurs National Park, Isle Royale National Park, and Rainbow Lakes Wilderness Class I areas were estimated for each of three years and are provided in Table 5.2.7-13. As shown in the table, all of the concentrations, except for the maximum 24-hour PM_{10} concentration at BWCAW, are below their respective Class I SIL threshold. This indicates that the NorthMet Project Proposed Action would not cause or contribute to significant effects for these pollutants and averaging times. The exceedance of the PM_{10} 24-hour Class I SIL at BWCAW triggers an additional cumulative modeling analysis, including all nearby increment consuming and expanding PM_{10} sources. The cumulative analysis for this pollutant and averaging period are discussed in Section 6.2.7.

Table 5.2.7-13 Summary of Prevention of Significant Deterioration Class I Increment Analysis

Pollutant	Averaging Period	Year Evaluated 2002	2003	2004	Max (μg/m^3)	Class I Inc (μg/m^3)	Class I SIL (μg/m^3)
		Boundary Waters Canoe Area Wilderness					
SO_2	3-Hour	0.106	0.082	0.088	0.106	25	1
	24-Hour	0.020	0.025	0.021	0.025	5	0.2
	Annual	0.001	0.001	0.001	0.001	2	0.1
NO_2	Annual	0.037	0.036	0.029	0.037	2.5	0.1
PM_{10}	24-Hour	0.331	0.263	0.278	**0.331**	8	0.3
	Annual	0.016	0.020	0.015	0.020	4	0.2
		Voyageurs National Park					
SO_2	3-Hour	0.014	0.010	0.020	0.020	25	1
	24-Hour	0.004	0.005	0.004	0.005	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.004	0.005	0.005	0.005	2.5	0.1
PM_{10}	24-Hour	0.072	0.131	0.081	0.131	8	0.3
	Annual	0.004	0.004	0.004	0.004	4	0.2
		Isle Royale National Park					
SO_2	3-Hour	0.001	0.001	0.001	0.001	25	1
	24-Hour	0.001	0.000	0.000	0.000	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.002	0.001	0.001	0.002	2.5	0.1

Pollutant	Averaging Period	Year Evaluated 2002	2003	2004	Max ($\mu g/m^3$)	Class I Inc ($\mu g/m^3$)	Class I SIL ($\mu g/m^3$)
PM_{10}	24-Hour	0.031	0.018	0.019	0.031	8	0.3
	Annual	0.002	0.001	0.001	0.002	4	0.2
			Rainbow Lakes Wilderness				
SO_2	3-Hour	0.003	0.003	0.003	0.003	25	1
	24-Hour	0.001	0.001	0.001	0.001	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.002	0.002	0.002	0.002	2.5	0.1
PM_{10}	24-Hour	0.030	0.033	0.021	0.033	8	0.3
	Annual	0.002	0.001	0.002	0.002	4	0.2

In 2010, the USEPA promulgated a Class I increment for $PM_{2.5}$. However, the minor source baseline date for $PM_{2.5}$ has not been triggered for the NorthMet Project area. Therefore, a comparison of $PM_{2.5}$ concentration with the $PM_{2.5}$ Class I increment and SILs is not required and was not performed.

Class I Areas – Air Quality Related Values Impact Analysis

An air quality modeling analysis was conducted to estimate the effect of the NorthMet Project Proposed Action on air quality in Class I areas. The analysis addressed visibility impacts on the BWCAW, Rainbow Lakes Wilderness, Voyageurs National Park, and Isle Royale National Park. The Class I AQRV analyses also included sulfur and nitrogen deposition and SO_2 effects on soils, water, and vegetation. The results are discussed below.

Class I Visibility Analysis

A visibility/regional haze impact analysis was carried out for BWCAW, Voyageurs National Park, and Isle Royale National Park. The Rainbow Lakes Wilderness does not have an AQRV for visibility. The recommended methodology for assessing visibility impacts, according to 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 particle 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 represent potential adverse effects on visibility. These thresholds are 5 percent (a potentially detectable change) and 10 percent (a level that may represent an unacceptable degradation). In the revised FLAG guidance of 2010, the FLM also lists a threshold of less than 5 percent as "presumptive no adverse impact" when compared to the highest 98^{th} percentile daily predicted impact.

The FLAG 2010 guidance indicates that CALPOST Method 8 is now the preferred visibility impact calculation method for Class I AQRV analysis. Method 8 uses Class I area-specific monthly average relative humidity to calculate light extinction. Method 8 also compares visibility impacts with the 20 percent best pristine days. The previous preferred methodology, Method 2, used the CALPUFF-generated hourly relative humidity data to calculate light extinction. Method 2 compares visibility impacts on annual average pristine conditions. Since previous NorthMet Project Proposed Action modeling used the FLAG 2000 guidance, NorthMet Project Proposed Action visibility impact results calculated using both Method 8 and Method 2 are presented below for comparison.

Table 5.2.7-14 presents results of the initial CALPUFF visibility analysis following the previous FLAG methodology, Method 2, for each NorthMet Project Proposed Action scenario. The maximum change in light extinction for Voyageurs National Park and Isle Royale National Park is below the 5 percent threshold with changes predicted at 4.50 percent and 1.23 percent, respectively. The maximum change in light extinction at the BWCAW for the three years modeled was predicted to be 11.08 percent. The data in Table 5.2.7-14 indicate that calculated visibility impacts greater than 5 or 10 percent could occur at some point within the BWCAW on a small number of days each year.

Table 5.2.7-14 Class I Area Visibility Results for NorthMet Project Proposed Action (Method 2 Analysis)

Class I Area and Meteorological Data Year	Days with ≥5% Visibility Impact	Days with ≥10% Visibility Impact	Maximum Δb_{ext} (%)
	Scenario 1		
BWCAW 2002/2003/2004	8/1/0	1/0/0	11.08/7.88/4.66
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	2.28/4.50/2.76
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	1.12/1.13/1.23
	Scenario 2		
BWCAW 2002/2003/2004	7/1/0	1/0/0	10.88/7.75/4.56
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	2.23/4.41/2.72
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	1.10/1.11/1.20
	Scenario 3		
BWCAW 2002/2003/2004	7/1/0	1/0/0	10.99/7.82/4.61
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	2.26/4.46/2.74
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	1.11/1.12/1.22
	Scenario 4		
BWCAW 2002/2003/2004	3/1/0	0/0/0	9.44/6.80/3.97
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	1.84/3.80/2.39
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.93/0.93/0.99

Table 5.2.7-15 presents results of the initial CALPUFF visibility analysis following the current FLAG methodology, Method 8, for each NorthMet Project Proposed Action scenario. Method 8 requires the eighth-highest visibility impact to be compared with the 5 percent and 10 percent thresholds. The eighth-highest changes in light extinction for the BWCAW, Voyageurs National Park, and Isle Royale National Park are below the 5 percent threshold with changes predicted at 4.86 percent, 1.11 percent, and 0.44 percent, respectively, and demonstrate no expected adverse visibility impacts compared to pristine conditions. These results of the NorthMet Project Proposed Action reflect emission reduction measures to reduce the potential for visibility impacts in the BWCAQ, which include: upgrades to the insulation in the existing Crusher and Concentrator buildings, utilization of low-NOx space heating equipment, a plan to phase in vehicles that meet Tier 4 emission standards, use of efficient gen-set locomotives, the reduction

of dust collector exhaust for heating demand reductions, use of appropriate pollution control equipment, and use of lower emitting fuels where feasible.

Table 5.2.7-15 Class I Area Visibility Results for NorthMet Project Proposed Action (Method 8 Analysis)

Class I Area and Meteorological Data Year	98% Days with ≥5% Visibility Impact	98% Days with ≥10% Visibility Impact	8th Highest Δb_{ext} (%)
	Scenario 1		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.86/3.92/3.85
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.89/1.11/0.97
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.44/0.21/0.23
	Scenario 2		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.74/3.83/3.80
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.85/1.09/0.96
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.43/0.19/0.22
	Scenario 3		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.80/3.87/3.83
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.86/1.09/0.97
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.43/0.20/0.22
	Scenario 4		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.21/3.45/3.42
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.74/0.97/0.82
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.36/0.17/0.19

Effects on Soils, Waters, and Vegetation

Deposition of Nitrogen and Sulfur

Potential effects on 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 NorthMet Project Proposed Action emissions from the Mine Site and Plant Site. Impacts were evaluated according to the USFS publication "Screening Procedures to Evaluate Effects of Air Pollution on Eastern Wildernesses Cited as Class I Air Quality Areas." Criteria for assessment of deposition impacts are different for USFS areas (BWCAW and Rainbow Lakes Wilderness) and National Park System areas (Voyageurs National Park and Isle Royale National Park). The National Park Service has established a DAT of 0.01 kg/ha/yr for both sulfur and nitrogen deposition for Class I areas in the eastern United States. The DAT is a level below which adverse effects from a new or modified source are not anticipated and are considered insignificant. The USFS has established Green Line Values for assessing impacts of deposition at BWCAW and Rainbow Lakes Wilderness, 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 effects (Barr 2012). As such, for BWCAW and Rainbow Lakes Wilderness, background deposition levels are added to the maximum NorthMet Project Proposed Action impacts from all scenarios to assess against Green Line Values. The current background nitrogen deposition for Rainbow Lakes Wilderness (5.88 kg/ha/yr) is at the Green Line Value range for nitrogen (5 to 8 kg/ha/yr). All other background deposition values for BWCAW and Rainbow Lakes Wilderness are below their respective Green Line Values (see Table 5.2.7-16).

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 NorthMet Project Proposed Action maximum annual average emissions. 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 effects of nitrogen and sulfur deposition for the Class I areas are shown in Table 5.2.7-16. As stated earlier, Green Line Values (Wilderness Areas) are compared to the maximum modeled NorthMet Project Proposed Action deposition plus background; the DAT values (National Parks) are compared to the modeled NorthMet Project Proposed Action effects only. As seen from the table, the maximum predicted total sulfur and nitrogen deposition are all below Green Line Value ranges for BWCAW. The maximum predicted total sulfur deposition is also below the Green Line Value for Rainbow Lakes Wilderness. However, the maximum predicted total nitrogen deposition at Rainbow Lakes Wilderness (5.9 kg/ha/yr) is within the Green Line Value range of 5 to 8 kg/ha/yr. The nitrogen deposition contribution from the NorthMet Project Proposed Action emissions is 0.02 percent of the total nitrogen deposition impact (0.001 kg/ha/yr). Table 5.2.7-16 also compares the ambient annual and 3-hour SO_2 concentrations due to the NorthMet Project Proposed Action to the Green Line Values. Modeled concentrations of SO_2 in both wilderness areas are below the Green Line Values for SO_2 concentration.

Finally, Table 5.2.7-16 compares terrestrial impacts of sulfur and nitrogen deposition in the Class I areas to the DAT values. The maximum predicted total sulfur and nitrogen values are below the DAT value of 0.01 kg/ha/year.

Table 5.2.7-16 Terrestrial Effects of Annual Deposition of Sulfur and Nitrogen from the NorthMet Project Proposed Action in Class I Areas

Class I Area	Proposed Action Effects	Background Level	Total (Proposed Action + Background)	Terrestrial Green Line Value	Deposition Analysis Threshold
BWCAW					
Annual avg. SO_2 ($\mu g/m^3$)	0.001	1.2	1.2	5 $\mu g/m^3$	NA
3-hour max. SO_2 ($\mu g/m^3$)	0.105	10.8	10.9	100 $\mu g/m^3$	NA
Sulfur (kg/ha/yr)	0.000	2.85	2.9	5-7 kg/ha/yr	NA
Nitrogen (kg/ha/yr)	0.009	4.75	4.8	5-8 kg/ha/yr	NA
Rainbow Lakes Wilderness					
Ann. avg. SO_2 ($\mu g/m^3$)	0.000	1.6	1.6	5 $\mu g/m^3$	NA
3-hour max. SO_2 ($\mu g/m^3$)	0.003	14.4	14.4	100 $\mu g/m^3$	NA
Sulfur (kg/ha/yr)	0.000	2.98	3.0	5-7 kg/ha/yr	NA
Nitrogen (kg/ha/yr)	0.000	5.88	5.9	5-8 kg/ha/yr	NA

Class I Area	Proposed Action Effects	Background Level	Total (Proposed Action + Background)	Terrestrial Green Line Value	Deposition Analysis Threshold
Isle Royale National Park					
Sulfur	0.000	NA	NA	NA	0.01 kg/ha/yr
Nitrogen	0.000	NA	NA	NA	0.01 kg/ha/yr
Voyageurs National Park					
Sulfur	0.000	NA	NA	NA	0.01 kg/ha/yr
Nitrogen	0.001	NA	NA	NA	0.01 kg/ha/yr

Table 5.2.7-17 summarizes the aquatic effects from sulfur and nitrogen deposition for the Class I areas. Green Line Values for aquatic effects at the wilderness areas are based upon total sulfur deposition, as well as total sulfur deposition plus 20 percent of the total nitrogen deposition (sulfur + 20 percent nitrogen). Maximum predicted values for these two measures for all scenarios were below the Green Line Value ranges for BWCAW. The maximum predicted total sulfur deposition and total sulfur plus 20 percent nitrogen deposition for Rainbow Lakes Wilderness are just below the Green Line Value, and nearly all of the effects are associated with the current background level. Aquatic effects at the National Parks are also compared to the DAT values. The modeled maximum annual nitrogen and sulfur deposition effects due to the NorthMet Project Proposed Action have levels below the respective National Park Service DAT levels for both Voyageurs National Park and Isle Royale National Park. The highest effects are predicted in Voyageurs National Park, with values approximately one-tenth of the incremental DAT level for sulfur and one-fifth of the incremental nitrogen DAT level.

Table 5.2.7-17 Aquatic Effects of Deposition of Sulfur and Nitrogen from the NorthMet Project Proposed Action in Class I National Park Areas

Class I Area	Proposed Action Effects (kg/ha/yr)	Background Level (kg/ha/yr)	Total (Proposed Action + Background) (kg/ha/yr)	Aquatic Green Line Value (kg/ha/yr)	Deposition Analysis Threshold (kg/ha/yr)
BWCAW					
Total Sulfur	0.000	2.85	2.85	7.5-8.0	NA
Total S + 20% of Total N	0.002	3.80	3.80	9-10	NA
Rainbow Lakes Wilderness					
Total Sulfur	0.000	2.98	2.98	3.5-4.5	NA
Total S + 20% of Total N	0.000	4.16	4.16	4.5-5.5	NA
Isle Royale National Park					
Total Sulfur	0.000	NA	NA	NA	0.01
Total N	0.000	NA	NA	NA	0.01
Voyageurs National Park,					
Total Sulfur	0.000	NA	NA	NA	0.01
Total N	0.001	NA	NA	NA	0.01

SO_2 Effects on Flora and Fauna

Potential SO_2 effects on flora and fauna in Class I areas were evaluated using the model-predicted concentrations from NorthMet Project Proposed Action emissions. The USFS has set screening criteria for potential air pollution effects on vegetation for SO_2 as a total annual average ambient concentration of 5 µg/m^3. 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 USFS (i.e., BWCAW and Rainbow Lakes Wilderness) the same criteria were applied to Voyageurs National Park and Isle Royale National Park, which are administered by the National Park Service but do not have published standards similar to the USFS. Table 5.2.7-18 compares maximum CALPUFF NorthMet Project Proposed Action impacts from all scenarios and existing background concentrations to the Green Line screening levels for each Class I area. The summation of the NorthMet Project Proposed Action and background contributions is well below the Green Line levels so no threat to sensitive vegetation in Class I areas is expected from direct SO_2 emissions produced by the NorthMet Project Proposed Action.

There are no established screening criteria for NO_2 and PM_{10} for effects on flora and fauna. As shown in Class I increment modeling results (Barr 2012), modeled maximum annual concentrations of NO_2 and PM_{10} from the NorthMet Project Proposed Action are below the secondary NAAQS standards (protecting vegetation), so it is not expected that there would be impacts on the Class I areas from these pollutants.

Table 5.2.7-18 Comparison of Projected Class I SO_2 Concentrations to Green Line Screening Criteria for Vegetation Effects

Class I Area	Background Air Concentration (μg/m^3)	Max. Modeled Proposed Action Contribution (μg/m^3)	Total Proposed Action Air Concentration (μg/m^3)	Green Line Concentration (μg/m^3)
	Annual	Annual	Annual	Annual
BWCAW	1.2	0.001	1.2	5
Isle Royale National Park	2.0	0.000	2.0	5
Rainbow Lakes Wilderness	1.6	0.000	1.6	5
Voyageurs National Park	0.7	0.000	0.7	5

5.2.7.2.3 Potential Estimated Human Health Risk from the Plant and Mine Sites

This section includes the assessment of potential human health effects from the NorthMet Project Proposed Action. Separate AERAs were conducted for the Mine Site and Plant Site due to the large distances (approximately 10 km) between the Mine Site and Plant Site sources. It should be noted that AERAs from the Mine Site and Plant Site are also considered cumulatively in Section 6.7.5.

Estimations of additional lifetime cancer risk were conducted for both the 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 off-site 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 Air Emissions Risk Analysis

An AERA was conducted for the Mine Site and results were reported in the scoping EAW (May 2005). The 2005 AERA included specific CFPEs as defined in MPCA's AERA Guidance (MPCA 2004). In addition, a multi-media screening assessment was conducted to assess the potential for inclusion of sulfuric to supplement the risk assessment. NorthMet Project Proposed Action changes since May 2005 resulted in the AERA being revised for the DEIS following an updated version of the AERA guidance (MPCA 2007). A Supplemental AERA was conducted, as part of the project changes defined with the current NorthMet Project Proposed Action (Supplemental Air Emission Risk Analysis – Mine Site, Barr 2012). The screening human health risk analysis followed the MPCA-accepted November 2011 Work Plan (Work Plan_AERA Supplement for NorthMet Mine Site, Barr 2011). As identified in the Mine Site AERA, the quantitative evaluation identified 11 chemicals for evaluation (CFEs), which are summarized in Table 5.2.7-19. The identified CFEs include seven risk driver chemicals from the 2007 AERA (arsenic compounds, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, manganese compounds, nickel compounds, NO_2, and dioxins/furans). The remaining four compounds are from the 2007 AERA that now have toxicity values (acetaldehyde, cobalt compounds, crystalline silica, and diesel particulate).

Table 5.2.7-19 Chemicals for Evaluation of the Incremental Human Health Risk Assessment for the Mine Site

Chemical	**Total Mine Site Emissions (Year 8) (lb/hr)**	**Total Mine Site Emissions (Year 8) (tons/yr)**	**Total Mine Site Emissions (Year 13) (lb/hr)**	**Total Mine Site Emissions (Year 13) (tons/yr)**
Acetaldehyde	4.11E-05	2.34E-06	4.11E-05	2.34E-06
Arsenic	0.0013	0.0004	0.0014	0.0005
Cobalt	0.0036	0.0025	0.0040	0.0027
Crystalline Silica	0.5820	0.3952	0.6467	0.4339
Dibenzo(a,h)anthracene	3.15E-06	2.58E-06	3.15E-06	2.58E-06
Diesel Particulate Matter	0.3143	0.2258	0.3143	0.2258
Indeno(1,2,3-cd)pyrene	3.68E-06	3.01E-06	3.68E-06	3.01E-06
Manganese	0.0638	0.0450	0.0702	0.0488
Nickel	0.0245	0.0152	0.0266	0.0166
Oxides of Nitrogen	14.6284	9.3759	14.6284	9.3759
Dioxins/Furans (as 2,3,7,8-TCDD TEQ)	4.12E-10	3.73E-10	4.12E-10	3.73E-10
Number of CFEs	11			

Estimations of additional lifetime risk were conducted for the MEI concept for both residential and farmer receptors. The resident is assumed to inhale outdoor air, and ingest soil and produce grown at a site of maximum air concentration. The farmer scenario assumed inhalation of outdoor air, ingestion of soil and produce, and also includes ingestion of meat products grown at the location of maximum air concentration.

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 13, which were determined to be the years of highest air emissions. Direct and indirect risk estimates were made for inhalation and bioaccumulative toxic pollutant ingestion, respectively, using the MPCA Risk Analysis Screening Spreadsheet (RASS), which 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 Mine Site property boundary (See Large Figure 4 in Barr 2013j). 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 processing plant air boundary (See Large Figure 5 in Barr 2013k). The former LTVSMC processing plant 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 either presently or 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) and indirect exposure (bioaccumulative toxic pollutant ingestion) at the Mine Site property boundary for off-site workers were below guidance levels, and the acute noncarcinogenic inhalation health effects were also below the guidance level (Supplemental Air Emission Risk Analysis – Mine Site, Barr 2012). The MEI inhalation pathway additional lifetime cancer risk at the former LTVSMC processing plant ambient air boundary was estimated from the assessment of year 13 emissions with a maximum value of 5E-06, which is below the MDH guideline value of 1E-05. The maximum sub-chronic and acute non-cancer MEIs were calculated to be 0.8 and 0.2 respectively, which are both below the guidance level of 1.0.

The MEI multi-pathway (direct and indirect) cancer risk was estimated to be 1E-05 for farmers using the Mining/Industrial District boundary. This is at the MDH additional lifetime cancer risk guidance level of 1E-05. The major risk drivers were dioxins and dibenzo(a,h)anthracene associated with potential emissions from diesel fuel combustion in mine vehicles. It should be noted that maximum multi-pathway additional lifetime cancer risk is located at the Mining/Industrial District boundary. The nearest small farms are located 6.5 miles from the Mine Site.

The MEI multi-pathway additional lifetime cancer risk for a hypothetical nearby resident at the Mining/Industrial District boundary was 8E-07, which is below the MDH guidance value of 1E-05. The major risk drivers for cancer endpoints for this receptor were nickel compounds, arsenic compounds, and dioxins.

The non-cancer chronic MEI multi-pathway HI for the farmers and residents were each calculated to be 0.04, which is below the MDH guidance value of 1.0. 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' health benchmark and compared to a general guidance value for chronic HI as 1.0. Thus, the potential health effects impacts for both farmer and residents assessed under the MEI concept are approximately 40 percent of the chronic guidance level.

The acute non-cancer MEI HI was predicted at the Plant Site operating boundary with a value of 0.8, 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 were NO_2 from the natural gas combustion. 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 for the off-site worker was reduced to 0.8, below the acute guidance level. Table 5.2.7-20 provides a summary of the Mine Site risk assessment.

Table 5.2.7-20 Summary of the Incremental Human Health Risk Assessment for the Mine Site

Exposure Route	Exposure Scenario	MEI Receptor	Potential Noncancer Health Effects (Hazard Index)[1]	Potential Cancer Effects (Risk Estimate)[2]
Inhalation Exposure Only	Acute (1-hour)	Mine Site Property Boundary	0.80	NA
	Chronic (> 1 year)	Mine Site Property Boundary	0.20	5E-06
Multipathway Exposure	Chronic (> 1 year)	Farmer	0.04	1E-05
		Resident	0.04	8E-07

[1] Hazard Index is the sum of individual non-cancer chemical risks for acute or chronic exposure. Incremental non-cancer (chronic and acute) guideline value is 1.0.
[2] Potential human health risks from carcinogenic chemicals (summed for all chemicals) were estimated using the MPCA's Risk Assessment Screening Spreadsheet. Incremental cancer risk guideline value is 1E-05.

Plant Site Air Emission Risk Analysis

As with the Mine Site, an AERA was conducted for the Plant Site and results were reported in the scoping EAW (May 2005). The 2005 AERA included specific CFPEs as defined in MPCA's AERA Guidance (MPCA 2004). NorthMet Project Proposed Action changes since May 2005 resulted in the AERA being revised for the DEIS. A Supplemental AERA was conducted, as part of the changes defined with the current NorthMet Project Proposed Action (Supplemental Air Emission Risk Analysis – Plant Site, Barr 2012). The screening human health risk analysis followed the MPCA-accepted August 2011 Work Plan (Work Plan_AERA Supplement for NorthMet Plant Site, Barr 2011). As identified in the Plant Site AERA, the quantitative evaluation identified 10 CFEs, which are summarized in Table 5.2.7-21. The identified CFEs include three risk driver chemicals from the 2007 AERA (arsenic compounds, nickel compounds, and NO_x) and four compounds from the 2007 AERA that now have toxicity values (acetaldehyde, cobalt compounds, crystalline silica, and diesel particulate). The remaining three were added either because of increased emissions (hydrochloric acid and manganese) or new emissions from mobile diesel sources included in the analysis (dioxins/furans).

Table 5.2.7-21 Chemicals for Evaluation of the Incremental Human Health Risk Assessment for the Plant Site

Chemical	Emissions 2011 (lb/hr)	Emissions 2011 (tpy)
Acetaldehyde	1.66E-05	9.49E-07
Arsenic	3.03E-03	7.75E-04
Cobalt		5.44E-03
Crystalline Silica		1.30E+00
Diesel Particulate Matter		4.47E-02
Hydrochloric Acid	2.45E+00	2.90E-02
Manganese		5.91E-02
Nickel	1.33E-01	1.36E-01
Oxides of Nitrogen	1.10E+01	
Dioxins/Furans (as 2,3,7,8-TCDD TEQ)		1.12E-10
Number of CFEs		10

Similar to the Mine Site AERA, air dispersion modeling was conducted to assess the 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 RASS, which 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 NorthMet Project area ownership boundary for off-site workers. 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 processing plant air boundary. The former LTVSMC processing plant 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 CFEs maximum concentrations are assumed to occur at the same location. A refinement to the risk assessment is the calculation of maximal potential health effects paired in 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 effects are at or below guidance levels and the acute noncarcinogenic health effects are also below the guidance level, when adjusted for locational differences (Supplemental Air Emission Risk Analysis – Plant Site, Barr 2012).

The MEI multi-pathway additional lifetime cancer risk at the former LTVSMC processing plant ambient air boundary was estimated to be 1E-05 for farmers and 5E-06 for a hypothetical nearby residents, which is below the MDH guidance level value of 1E-05. Similarly, the RME-OSW inhalation additional lifetime cancer risk at the NorthMet Project area boundary was predicted at 1E-05, also at the MDH additional lifetime cancer risk guidance level. The major risk drivers for these estimated cancer endpoints were cobalt, nickel, and dioxins/furans (farmers only).

The non-cancer chronic MEI multi-pathway HI for the farmers and residents were each calculated to be 0.2, primarily from the potential NO_x and 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 HI is the sum of the individual ratios of the maximum concentration divided by the chemicals' REL and compared to a general guidance value for chronic HI as 1.0. Thus, the potential health effects on both farmer and residents assessed under the MEI concept are approximately 20 percent of the chronic guidance level. The chronic HI for the RME-OSW receptor was predicted to be 1, which is at the chronic guidance level.

The results of the acute non-cancer MEI HI were predicted at the Plant Site operating boundary with a value of 0.5, 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 were NO_2 from the natural gas combustion and nickel from the Hydrometallurgical Plant. 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 for the off-site worker was 1.0, at the acute guidance level. Table 5.2.7-22 provides a summary of the Plant Site risk effects.

Table 5.2.7-22 Summary of the Incremental Human Health Risk Impacts for the Plant Site

Exposure Route	**Exposure Scenario**	**MEI Receptor**	**Potential Noncancer Health Effects (Hazard Index)[1]**	**Potential Cancer Effects (Risk Estimate)[2]**
Inhalation Exposure Only	Acute (1-hour)	Off-Site Worker Plant Site Property Boundary	1.0	NA
	Acute (1-hour)	Resident at former LTVSMC ambient air boundary	0.5	NA
	Chronic (> 1 year)	Mine Site Property Boundary	1.0	1E-05
Multipathway Exposure	Chronic (> 1 year)	Farmer	0.2	1E-05
		Resident	0.2	5E-06

1 Hazard Index is the sum of individual non-cancer chemical risks for acute or chronic exposure. Incremental non-cancer (chronic and acute) guideline value is 1.0.
2 Potential human health risks from carcinogenic chemicals (summed for all chemicals) were estimated using the MPCA's Risk Assessment Screening Spreadsheet. Incremental cancer risk guideline value is 1E-05.

5.2.7.2.4 Greenhouse Gases Impact Analysis

The science, policy, and regulatory frameworks regarding GHGs are continually evolving and are often subject to differing interpretation. For the purposes of the SDEIS, the information presented below is intended to provide the current understanding through June 15, 2012 with subsequent information regarding climate change updated in the FEIS.

<u>Global Effects</u>

According to the IPCC, evidence has led 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 GHGs in the earth's atmosphere since preindustrial times (IPCC 2007). It is estimated that 40 percent of a pulse emission of CO_2 remains in the atmosphere for approximately 100 years. Approximately 15 to 30 percent of the emissions are expected to remain after 1,000 years and 10 to 15 percent 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 GHG levels are likely to continue to rise over the next few decades. The body of evidence has led scientists to conclude with 90 percent certainty that higher levels of atmospheric GHG 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). Other data have shown that the global average temperature has increased by about 1.2 to 1.4°F since 1890, with the 14 warmest years of the past century occurring between 1997 and 2012 (NASA 2013).

The IPCC’s most recent report (IPCC 2007) found that, under a business-as-usual scenario, globally averaged surface temperature would increase 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°F per decade (NOAA 2007). The annual average temperature of Minnesota has increased approximately 1°F in the last century, from 43.9°F (1888 to 1917 average) to 44.9°F (1963 to 1992 average) (MPCA 2009). The winter season has brought even more dramatic increases of up to five degrees in parts of northern Minnesota (MPCA 2009). 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 as well as changes in other meteorological conditions, such as precipitation patterns and shifts in seasons. These changes 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 GCMs, suggest an increase in annual precipitation of 10 to 15 percent 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 would increase 20 to 25 percent; summer rainfall declines 5 to 10 percent in the model results.

Although the degree of effect is uncertain, particularly when analyzed at the regional and local levels, water resources could be affected by changes in climate patterns. Due to increased temperature, evaporation would likely increase which could reduce levels in lakes, rivers, and streams up to 12 inches (MDNR 2009). Increased precipitation could also affect flooding conditions. In addition, severe weather patterns could be affected, resulting in more frequent 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 to 70 percent (MPCA 2003). 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 increased 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 areas and wetland gains in other areas.

Climate change could have a dramatic effect on agriculture due to increased water demand from increased evaporation. However, it may also increase the potential growing season of certain crops within the region, creating a further increase in the use of water resources. In addition, increased growing seasons may increase droughts, floods, insects, and weeds, which would increase the challenges in managing farms and livestock.

Increased temperatures could increase the potential for heat-related illnesses and insect-borne diseases. Changes in air quality health effects could occur due to the increased temperatures. The potential for higher VOC and ozone levels, as well as increased duration and frequency of stagnation conditions would allow air pollution to build up.

Regulatory Actions

The USEPA has issued regulations under the CAA, and in some cases other statutory authorities, to address issues related to climate change. In addition, MPCA has recently modified its air permit rules to incorporate new federal permit requirements for GHG emissions and currently requires an evaluation of GHG emissions in the environmental review process for projects that must obtain stationary source air permits.

On October 30, 2009, the Final Mandatory Greenhouse Gas Reporting Rule was published requiring suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 or more mtpy of GHGs to submit annual emission reports to USEPA. The gases covered by the proposed emissions reporting rule are CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and other fluorinated gases including NF_3 and HFE. The proposed rule required that the first annual GHG emission report be submitted on March 31, 2011, for 2010 emissions. The first reporting deadline was extended to September 20, 2011.

In response to the 2007 United Stated Supreme Court ruling in Massachusetts v EPA, 549 US 497 (2007), on April 17, 2009 the USEPA Administrator signed a Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Section 202a of the CAA. The Administrator found that current and projected concentrations of the mix of six key GHGs in the atmosphere threaten the public health and welfare of current and future generations. The Administrator further found that the combined emissions of CO_2, CH_4, N_2O, and HFCs from motor vehicles and motor vehicle engines contribute to rising atmospheric concentrations of these key GHGs and hence are a threat to public health and welfare. These findings were a prerequisite to finalizing the GHG standards for light-duty vehicles. On April 1, 2010, USEPA and the DOT's National Highway Safety Administration issued the first national rule limiting GHG emissions from cars and light trucks. This rule confirmed that January 2, 2011 is the earliest data that a 2012 model year vehicle meeting these rule requirements may be sold in the U.S.

Based upon the above and USEPA's "PSD Interpretive Memo" (identifying that a pollutant is subject to regulation either by a specific provision in the CAA or a regulation adopted by USEPA), USEPA issued a final rule on May 13, 2010 that set GHG thresholds for permits for new and existing sources under New Source Review PSD permit and Title V operating permit requirements, known as the Greenhouse Gas Tailoring Rule. Currently, under the rule and beginning on July 1, 2011, through June 30, 2013, new sources, such as the NorthMet Project

Proposed Action, with greater than 100,000 tpy of GHG or existing facilities that increase their GHG emissions by more than 75,000 tpy are subject to PSD and would require BACT for GHG emissions.

Concurrent with USEPA actions, a series of Congressional proposals have been developed that would have the effect of shaping U.S. climate policy. GHG emissions legislation considered during the 109th and 110th sessions (January 2005 to January 2007, and January 2007 to January 2009, respectively) of the U.S. Congress ranged from carbon taxes to cap-and-trade and from energy efficiency requirements to moratoriums on coal-fired power plant approvals. Notable recent legislative actions include the following:

- Lieberman-Warner Climate Security Act of 2007 (S. 2191);
- Boxer-Lieberman-Warner Climate Security Act Substitution Amendment of 2008 (S. 3036);
- American Clean Energy and Security Act of 2009 (Waxman-Markey – H.R. 2454);
- Clean Energy Jobs and American Power Act of 2009 (Kerry-Boxer (S. 1733)); and
- Kerry-Lieberman American Power Act of 2010.

None of these bills have passed both houses of Congress.

At the state level, efforts to curb statewide and regional GHG emissions are underway. More than half of U.S. states have joined in regional efforts to reduce GHG emissions. In 2007, as part of the Midwestern Greenhouse Gas Reduction Accord, Minnesota committed (along with Illinois, Iowa, Kansas, Michigan, Wisconsin, and the Province of Manitoba, Canada) to long-term GHG reduction targets of 60 to 80 percent below 2005 emission levels. Participants have agreed to pursue the implementation of a regional cap-and-trade system as well as a consistent regional GHG emissions tracking system.

In May 2008, the Governor of Minnesota signed legislation requiring the Minnesota Department of Commerce and the MPCA to track GHG emissions and directed that interim reduction recommendations be developed, including a 15 percent reduction target for 2015 and a 30 percent reduction target for 2025, which could be in effect during the lifetime of the NorthMet Project Proposed Action. The interim goals are designed as milestones toward meeting the State's goal of reducing GHG emissions to a level at least 80 percent below 2005 levels by 2050. Developments in Minnesota's climate change and GHG policy would likely continue as Minnesota strives to meet the goals established in the Next Generation Energy Act of 2007.

On January 13, 2013, the MPCA adopted permanent rules to implement the new GHG permit requirements set by the USEPA. These rules set Part 70 permit thresholds for GHGs at 100,000 tpy. The rule changes also modify requirements for capped and registration permits and insignificant activities. The MPCA has implemented USEPA's final decision to defer including biogenic CO_2 emissions in permitting through permanent rulemaking for biogenic sources for PSD and Title V purposes.

In addition to policies directed at reducing statewide GHG emissions, Minnesota has instituted policies requiring the evaluation of GHG emissions as a part of the environmental review process for certain proposed actions that require stationary source air emissions permits. In July 2008, MPCA issued a General Guidance for Carbon Footprint Development in Environmental Review. The MPCA guidance requests that proposers, in the course of environmental review under

MEPA, prepare a GHG inventory for proposed actions that would require stationary source air emissions permits.

NorthMet Project Proposed Action and Climate Change

The NorthMet Project Proposed Action results in direct on-site emissions of GHGs and off-site indirect emissions associated with power generation. There are no analytical or modeling tools to reliably evaluate the incremental impact of a proposed action's discrete GHG emissions on the global and regional climate. In addition, there are no analytical or modeling tools to reliably evaluate any cascading impacts, or cumulative effects, from a particular proposed action's GHG emissions on natural ecosystems and human economic systems in a given state or region.

The total potential direct annual emissions from the NorthMet Project Proposed Action are projected to be 186,243 tpy of CO_2e. This is 0.12 percent of the statewide emissions for Minnesota, 0.003 percent of the United States emissions, and 0.00038 percent of the annual global emission estimations. Combining the direct and indirect emissions from the NorthMet Project Proposed Action (697,342 mtpy CO_2e), the total represents 0.44 percent, 0.01 percent, and 0.0014 percent of the annual statewide, U.S., and global emissions, respectively (Greenhouse Gas and Climate Change Evaluation, Barr 2012).

With climate change, average annual temperatures in Minnesota may increase 3 to 5°F over the lifetime of the facility. There may also be a 5 to 15 percent increase in precipitation over the life of the operation (20 years) and reclamation (60 years) (Regional Climate Trends and Scenarios for the U.S. National Climate Assessment Part 3: Climate of the Midwest, NOAA 2013). Increased temperatures and precipitation may have effects on wetlands, forests, and other cover types that are likely to affect carbon storage and sequestration in these ecosystems. Overall climate change could also affect visibility. There could be localized impacts due to meteorological changes. Although, over its life, the NorthMet Project Proposed Action would emit GHGs to the atmosphere, it is possible that, due to global demand for copper, nickel, and precious metals, some of these emissions will occur regardless of the development of the NorthMet Project Proposed Action. Even though a quantitative assessment of the effects could not be conducted, proposed reclamation and mitigation activities described in Section 5.2.7.4.3 can offset some of the carbon emissions caused by NorthMet Project Proposed Action.

5.2.7.2.5 Mercury Deposition Impact Analysis

Total potential mercury emissions to air are estimated to be 4.6 lbs/year from the Plant Site. The primary sources of air emissions are expected to be two emission units that are part of the hydrometallurgical process: the autoclave vent and the autoclave flash vent. The combined air emissions from these two units are estimated to be 4.1 lbs/year. Most of the remaining estimated mercury emissions (0.5 lb/year) are from natural gas used to fuel a package boiler and for space heating. Less than 0.1 lb/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 *Mercury Emission Control Technology Review Version 2* (Barr 2012g). Overall, about 95 percent of the mercury originating in the ore is expected to remain within—or be adsorbed to—the tailings and the hydrometallurgical residue, where it would remain isolated from further transport to the environment.

The low percentage of estimated mercury released to the air is primarily because the oxidizing conditions in the autoclave would 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 be 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 in the elemental (Hg^0) form. Detailed calculations for all Plant Site emission units are provided in UpdatedCalcsPlant Ver7.0_2_26_13 (Barr 2013).

An evaluation was conducted for the potential deposition of mercury related to the Plant Site air emissions to assess the NorthMet Project Proposed Action's potential effects on 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 analysis was conducted for five nearby lakes: Heikkilla Lake, Colby Lake, and Whitewater Lake (located within 10 km of the Plant Site) and Wynne Lake and Sabin Lake (located within 12 km of the Plant Site). The analysis used the MPCA model MMREM to assess the potential incremental change in fish mercury concentrations and the potential incremental risks to human health.

Only the Plant Site's potential mercury air emissions were evaluated, as they represent essentially all of the NorthMet Project Proposed Action-related mercury air emissions (Barr 2013). The Mine Site AERA did not assess potential local mercury deposition because potential emissions are less than 1.0 lb/yr (Barr 2012a).

The results of the analysis from the two mercury speciation scenarios on the five nearby lakes estimated that the potential incremental increase in mercury concentrations in the top predator fish would range from 0.001 ppm (Scenario 2, Whitewater Lake) to 0.016 ppm (Scenario 1, Wynne Lake), depending upon the lake and scenario evaluated (see Revised Table 4, Barr 2013). Scenario 1 assumed that the oxidized and particle-bound mercury released would be 50 percent and 25 percent of the total mercury, respectively. Scenario 2 assumed maximum efficiency for these fractions, reducing the total percentage released to 10 percent for each. It should be noted that due to the conservatively higher oxidized and particle-bound mercury speciation assumption in Scenario 1, the effects for Scenario 1 are greater than the mercury effects for Scenario 2 for each lake evaluated. These are small compared to the existing Hg concentrations in the top predator fish (95^{th} percentile), which range from 0.35 ppm at Whitewater Lake to 1.34 ppm at Wynne Lake. The NorthMet Project Proposed Action incremental risk quotients for a recreational fisher ranged from 0.013 (Scenario 1) at Whitewater Lake to 0.081 at Wynne Lake; both are below the incremental risk guideline level of 1.0. The incremental risk quotients for subsistence and tribal anglers ranged from 0.098 (Whitewater Lake) to 0.606 (Wynne Lake) for Scenario 1, also below the incremental risk guidance level. Finally, the incremental risk quotients for the subsistence fisher (Treaty Protected catch rate) ranged from 0.132 (Scenario 1, Whitewater Lake) to 0.538 (Scenario 1, Wynne Lake), again below the incremental risk guidance level.

It should be noted that all of the lakes' mercury background concentrations result in a background risk quotient above 1.0 without any incremental increase from the NorthMet Project Proposed Action, which is a common occurrence in Minnesota lakes. Widespread contamination of fish from atmospheric pollution is why Minnesota established a statewide mercury TMDL. The TMDL seeks to reduce atmospheric deposition everywhere in the state in order to make the state's lakes and streams fishable, as required by federal regulations.

In September 2009, the MPCA published Guidelines for New and Modified Mercury Air Emission Sources. The guidelines were developed to limit the mercury emissions from new and expanding sources in order to meet the TMDL goal of total statewide mercury emissions of 789 lbs/year by 2025. In 2012, MPCA revised the guidelines (MPCA 2012), which includes the following requirements that apply to the NorthMet Project Proposed Action:

- Define and employ BACT on mercury emitting sources. If best controls reduce emissions by less than 90 percent, the new source would be subject to periodic review for opportunities for improved control efficiency.
- Conduct environmental analysis for a proposed action and associated cumulative effects.
- For facilities where the MPCA determines a project’s mercury emissions will not impede the statewide mercury emissions reduction goals within the mercury TMDL, an emissions limit will be placed into the facility’s permit and the project is not be required to submit a mitigation plan.

The NorthMet Project Proposed Action complied with these requirements by selecting a two-stage emissions control system as the BACT system for the autoclave, which is capable of reducing the mercury emissions over 90 percent (Barr 2012g). In addition, PolyMet has conducted a cumulative effects analysis on the local mercury deposition and bioaccumulation in fish (Barr 2012g) and the assessment of the cumulative effects is provided in Section 6.7.5.

MPCA has conducted a review of the NorthMet Project Proposed Action mercury emissions and has determined that it will not impede the reduction goals (MPCA 2013c). Thus, no minimization and mitigation plan will be required for the NorthMet Project Proposed Action.

5.2.7.3 NorthMet Project No Action Alternative

Since this alternative would not involve introducing new emission sources, the NorthMet Project No Action Alternative would have no additional effects on air quality either regionally or locally. Therefore, air quality would be substantially similar to existing conditions.

5.2.7.4 Mitigation Measures

If, during permitting, it is determined that mitigation measures are necessary, the measures described in this section could be considered. PolyMet has proposed the following mitigation measures to reduce effects on air quality associated with GHGs.

5.2.7.4.1 Greenhouse Gas Reduction Measures

Review of Current Mitigation Included In the NorthMet Project Proposed Action

The NorthMet Project Proposed Action incorporates both energy and production efficiency to reduce associated GHGs (Barr 2009). The potential to minimize and reduce GHG emissions from changes in existing land cover (i.e., release of carbon tied up in terrestrial biomass, soils, or peat and the loss of carbon sequestration capacity from the environment) are also discussed (Barr 2009). The following provides a summary of the reduction measures.

PolyMet proposes a hydrometallurgical process, rather than a pyrometallurgical process, which would result in reduced energy usage. The hydrometallurgical process is expected to reduce the NorthMet Project Proposed Action’s energy demand by 50 percent over comparable pyrometallurgical processes. However, while energy use is reduced by one-half, GHG 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.

PolyMet also proposes to use premium efficiency motors in selected locations rather than standard motors. Motor efficiencies typically vary between 85 and 96 percent, 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 processing plant such that the overall power factor for 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 GHG emissions. PolyMet would purchase new gen-set locomotives, which are more efficient and use less fuel than conventional locomotives. Space heating in the former LTVSMC processing plant is a major contributor to total direct GHG emissions and PolyMet would employ natural gas heaters. Per unit of useful energy, the combustion of natural gas results in lower CO_2e emissions than does the combustion of other fuels. Of the three feasible space heating options, electric heating, propane-fired heating, and natural gas-fired heating, natural gas-fired heating would result in aggregate in CO_2 emissions that would be about 80 percent lower than those for electric heating and 66 percent lower than those for propane-fired heaters.

PolyMet evaluated additional methods to reduce the NorthMet Project Proposed Action's GHG emissions but found the additional methods infeasible (Barr 2009). 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.

Additional Mitigation

To mitigate GHG effects associated with a change in existing land cover (i.e., secondary effects), PolyMet would implement a wetland mitigation plan (see Section 4.2 of this SDEIS) for reasonably foreseeable effects on 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 affected by the NorthMet Project Proposed Action. Given site limitations and technical feasibility, it is impracticable to replace all affected 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. Based upon the Wetland Mitigation Plan, the proposed wetland replacement would exceed all types of wetlands, other than open and coniferous bogs. However, the excess replacement would contribute to compensation of the NorthMet Project Proposed Action's effects on open and coniferous bog wetlands.

5.2.7.5 Amphibole Mineral Fibers

5.2.7.5.1 Environmental Consequences

Background

The NorthMet Project Proposed Action would mine ore from the Duluth Complex, which may contain amphibole fibers. Taconite ore mined from the Biwabik Iron Formation at the Northshore Mine and 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 U.S. 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 and non-asbestos amphibole fibers. The term "asbestos" 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. 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) in length or longer with an aspect ratio of at least 20:1 (USEPA 1993). A µm is one millionth (10^{-6}) of a meter. 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). Minnesota agencies define a MN-fiber as an amphibole or chrysotile mineral particle with an aspect ratio of 3:1 or greater with no limit on length (MDH Methods 851 and 852). This definition, which includes amphibole mineral fibers that can either be asbestos or non-asbestos, is consistent with the findings of *United States v. Reserve Mining Company*.

Asbestos Fibers

Asbestos is made up of fiber bundles with two or more of the following features:

- parallel fibers occurring in bundles;
- fiber bundles displaying splayed ends;
- matted masses of individual fibers; and
- fibers showing curvature.

Bundles have splaying ends and are extremely flexible. 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 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). In 2011, USEPA released a draft report, *Toxicological Review of Libby Amphibole Asbestos in Support of Summary Information on the Integrated Risk Information System Iris (USEPA 2011)* to characterize the hazards by exposure to Libby Amphibole Asbestos for carcinogenicity and noncancer health effects. The USEPA Scientific Advisory Board completed a comprehensive review of the report and provided recommendations on January 30, 2013. As part of the recommendations, the SAB recommended additional review be conducted to re-evaluate the uncertainty factors, including recent cohort studies conducted on amphibole fibers in Minnesota (USEPA 2013). A review of the toxicological literature for asbestos was performed for the MDNR (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. 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). 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).

From a mineral perspective, 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 not clear. Amphibole particles have a spectrum of shapes from blocky to prismatic to acicular to asbestiform. 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. Amphiboles also break (or cleave) into smaller fragments when finely ground. Long, thin cleavage fragments 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. 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. 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 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 to 50 years are not uncommon, creating uncertainties in the interpretation of studies performed to date. It should be noted that taconite is mined in the Biwabik Formation, whereas the ore proposed to be mined for the NorthMet Project Proposed Action is from the Duluth Complex, which is not in contact with the Biwabik Formation at the NorthMet Deposit.

Other Considerations

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 October 2005 SDD for the NorthMet Proposed Action EIS identified that the "… EIS will provide information about the presence of fibers in the NorthMet deposit." Since February 2006 fibers-related information has been submitted to the Minnesota State Agencies (MDNR; MPCA; MDH) for their review and consideration. The report entitled *NorthMet Mine and Ore Processing Facilities Proposed Action, Fibers Data Related to the Processing of NorthMet Deposit Ore* (2007), hereafter referred to as the "2007 Mineral Fibers Report," provided the bulk of the fibers-related data and information.

The Northshore Mine and Silver Bay processing plant have been associated with releases of amphibole mineral fibers to the air and water. The NorthMet Project area is in close proximity to the existing Northshore 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 the Northshore Mine in the Biwabik Iron Formation and was formed under different conditions (Barr 2007).

The 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). 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 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 (Barr 2007).

Amphibole and serpentine mineral fibers are of primary interest for the NorthMet Project Proposed Action. Overall, amphibole mineral fibers were found to represent a relatively small percent of the mineral fibers associated with the processing of NorthMet Deposit ore (Flotation Pilot Testing in July and August 2005); amphibole mineral fibers were approximately 9 percent of the fibers identified from all collected samples of ore, tailings, and process water. Serpentine mineral fibers were not identified in samples of ore, tailings, or process water collected from the flotation pilot testing. However, PolyMet's petrographic observations indicate that serpentine minerals are about 2 percent of the minerals associated with the waste rock from the NorthMet Project Proposed Action.

Data provided in the 2007 Mineral Fibers Report indicates that about 95 percent of the mineral fibers identified in samples collected from the flotation pilot testing were 3 microns or smaller in size, with most being less than 2 microns in size. Therefore, $PM_{2.5}$ (fine particulate) could be used as a surrogate for all mineral fibers, including amphibole and serpentine mineral fibers.

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-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.

5.2.7.5.2 Evaluation Criteria

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 58 cases of mesothelioma documented among the 72,000 workers in the study (MDH 2008).

Based upon a scientific review study on asbestos and elongated mineral particles conducted by NIOSH, the MDH has reported that males within the area of the taconite mining and milling industry had more than two times the mesothelioma rate than the rest of the state and that females had a lower mesothelioma rate than the state average; strongly suggesting an industrial etiology. However, the findings from the epidemiological case studies have suggested that the excess of mesothelioma observed among the taconite miners may have been from exposure to commercial asbestos, rather than from the nonasbestiform amphibole elongated mineral particles generated during the iron ore processing (NIOSH 2011).

The University of Minnesota is directing a $4.9 million research effort, funded by the State of Minnesota, which will lead to a greater understanding of taconite worker health issues, including an epidemiological investigation into causes of excess cases of mesothelioma among taconite workers. The program has 5 core design studies which include: occupational exposure assessment, mortality study, incidence studies, respiratory health survey of taconite workers and spouses, and environmental study of airborne particulates (UMN 2012).

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 does not consider fibers shorter than 10 µm in length. To date, there is no accepted methodology for performing a formal health risk assessment for the quantitative assessment of human health effects 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 NorthMet Project Proposed Action.

5.2.7.5.3 NorthMet Project Proposed Action

This section describes the likelihood of exposures to airborne amphibole mineral fibers from the proposed mining and processing operations. MN-fibers identified in samples collected from the 2005 flotation pilot testing of material representative of processing NorthMet Deposit ore (Barr 2007d) were predominately less than 2.5 µm in aerodynamic diameter (99.6 percent 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 percent).

Although not calculated from the flotation pilot testing data (Barr 2007d), the probability of amphibole mineral fibers released from the NorthMet Project Proposed Action is not zero. Potential airborne fibers could contain asbestos fibers, which have known health effects. However, based on the samples analyzed from the NorthMet Deposit (Barr 2007d) and from other data collected by the MEQB (1979) for the Duluth Complex, the probability of amphibole asbestos being released to air is very low. Non-asbestos amphibole mineral fibers in these emissions have less well known health effects; however, these fibers are regulated as MN-fibers under the MPCA permits. These fibers have been regulated by MPCA air and water permits at the Northshore Mining Company (formerly Reserve Mining Company) operation in Silver Bay since the Reserve decision. The MPCA and the MDH have emphasized additional control of fine particles to minimize potential exposure to amphibole mineral fibers.

PolyMet's June 2007 Fibers Data Report (Barr 2007a) included an assessment of alternative control technologies for the proposed Plant Site operations. These data were taken from a BACT-like analysis for $PM_{2.5}$ for the Plant Site prepared for PolyMet (Barr 2007c). At the time that the BACT report was submitted (February 2007), PolyMet's intention was to permit the project as a PSD major source, so the Plant Site would have been subject to BACT requirements for PM_{10}.

In a September 2007, Supplemental Fibers Data Report (Barr 2007b), PolyMet incorporated project changes made in a July 2007 Supplemental Detailed Project Description (Barr 2007g) to further reduce particulate matter and fugitive dust emissions from the Plant Site and Mine Site, as well as additional changes related to particulate matter control and monitoring for amphibole MN-fibers following August 2007 discussions.

PolyMet also submitted updated control technology reviews in October 2007 (RS58A Draft-02) and in February 2012 (Barr 2012h). 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 CAA that 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 effects and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques. This includes fuel cleaning or treatment or innovative fuel combustion techniques for control of such a pollutant. In no event shall application of BACT result in emissions of any pollutant that 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 BACT. Such standards would, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and would 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 cannot 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 NorthMet Project Proposed Action 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 vast majority of potential emissions of MN-fibers for the NorthMet Project Proposed Action would occur from the ore crushing operations at the Plant Site, with minor potential emissions from the Tailings Basin and the Mine Site (Barr 2007). The Tailings 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 the 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.

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.

PolyMet is proposing to permit the NorthMet Project Proposed Action as a synthetic minor source with respect to PSD regulations. Therefore, a BACT determination, required under PSD, does not apply. Recent BACT determinations were reviewed and evaluated to identify the best controls currently used in the metallic ore processing industries for fine particulates (Barr 2012h). As a result, the NorthMet Project Proposed Action would install emission controls in the crushing plant, such that the emissions of fine particulate matter from the ore crushing and associated material handling sources are controlled consistent with recent BACT determinations. The controls would include the use of fabric filters (baghouse or cartridge) designed to reduce emissions to 0.0025 gr/dscf at each unit (Barr 2011). These controls would be applied to all emission sources within the coarse crushing operations (10 units), the drive house (2 units), the fine crushers (8 units), and the concentrator (15 units).

In addition to these controls, the NorthMet Project Proposed Action would also use HEPA filters following the fabric filters on selected units. The HEPA filters would be used when exhaust air from the fabric filters is routed back into the building to provide an added level of assurance that worker exposure to inhalable dust is minimized. In this case, the venting of exhaust air back into a building provides a benefit of reducing the heating fuel demand that offsets the additional cost and energy usage associated with re-routing of air back into a building (Barr 2012h). The combination of the cartridge and HEPA filters for fine particulates has a removal efficiency of 99.97 percent. Six units within the coarse crushing operations and nine units within the concentrator would utilize the HEPA filters year-round. Eight of the 10 units within the drive house and fine crusher operations would utilize the HEPA filters during heating season only (Barr 2011).

As stated earlier, due to the size of the MN-fibers, $PM_{2.5}$ can be used as a surrogate in evaluating effects. The modeled $PM_{2.5}$ concentrations, presented in Section 5.2.7.4, include all other nearby sources, and demonstrate compliance with all ambient air quality standards. Thus, the use of HEPA filters, during non-essential operations, would provide little air quality benefits for reducing exposure to fine particulates outside the facility boundary. In addition, the modeled $PM_{2.5}$ effects demonstrate that the $PM_{2.5}$ concentrations rapidly decrease in magnitude in all directions. As such, the operational and air pollution equipment controls for the NorthMet Project Proposed Action represent the highest feasible level of fine particulate matter control and, coupled with Hoyt Lakes being 5 miles from the Plant Site, further reduce the potential for public exposure to airborne amphibole mineral fibers.

Baseline ambient air monitoring for mineral fiber concentration is currently being done at Hoyt Lakes. The monitoring location was approved by the MPCA and the monitoring is being conducted according to MPCA methodology. Ambient air monitoring for mineral fibers would also be conducted for one year following facility start-up. The mineral fibers data collected after the facility start-up would enable a comparison with the baseline conditions.

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5.2.8 Noise and Vibration

This section describes effects on humans, including effects on human recreational activity, of noise, vibration, and airblast related to the NorthMet Project Proposed Action. The effects on wildlife are described in Section 5.2.5.

Summary

Both noise and vibration dissipate with distance. The residences closest to the mine are at a distance where blasting and other NorthMet Project Proposed Action-related noise would not be heard. The NorthMet Project Proposed Action would comply with all daytime and nighttime regulatory noise limits at sensitive receptors, but the changes in total noise level from current conditions during nighttime operations would be perceptible. Immediate access to areas around the mine would be restricted, but hikers or other recreational users in the Superior National Forest, in areas immediately near the mine, may occasionally experience noise and/or vibration associated with the NorthMet Project Proposed Action.

5.2.8.1 Methodology and Evaluation Criteria

This section describes the methodologies and criteria used to evaluate potential noise, ground vibration, and airblast at areas of the Mine Site and Plant Site. NorthMet Project Proposed Action-related sound levels were estimated using the ISO 9613-2 sound-propagation model. The Site Law Formula was the basis for estimating vibration effects. Airblast was estimated using the Terrock model. Each is a desktop model that estimates project effects using site-specific conditions. Estimated effects were compared to federal, state, or local regulations or to project design standards, as appropriate. For noise and vibration, the area of potential effect was defined as a 20-mile radius from the Mine Site and a 20-mile radius from the Plant Site. The area of potential effect for airblast was the distance from the source where measured effects were below the known level for human effects.

5.2.8.1.1 Noise

<u>Noise Impact Assessment Methodology</u>

The noise impact assessment areas for the NorthMet Project Proposed Action include the noise-sensitive receptors within a 20-mile radius of the Mine Site and a 20-mile radius of the Plant Site. The 20-mile radius was selected in order to include the southern edge of the BWCAW, which is located approximately 20 miles north of the Mine Site and Plant Site. The ISO 9613-2 sound-propagation model (*Acoustics-Attenuation of Sound during Propagation Outdoors)* is accepted worldwide and was used to determine the extent of noise effects from the NorthMet Project Proposed Action. This model is the only one that encompasses a standardized method for calculating sound propagation and is the basis for most sophisticated computer modeling programs (Ray 2010). This sound-propagation model consists of octave-band algorithms with nominal mid-band frequencies from 63 to 8,000 Hz for computing the attenuation of sound originating from a point sound source or an assembly of point sources. The source(s) may be mobile or stationary. The model predicts equivalent continuous A-weighted sound pressure levels (L_{eq}) from sources of known sound emission and accounts for the following site conditions and physical effects:

- Meteorological conditions favorable to sound propagation (i.e., downwind propagation with wind speeds between 1 and 5 meters per second when measured 3 to 11 meters above the ground). This is a conservative approach because not all receptors may be located downwind of the sources (i.e., receptors located upwind would experience less noise since noise propagates farther downwind than upwind).
- Topography and the extent of ground absorption from different surfaces.
- Noise emission of each source, as well as its location and elevation.
- Location and elevation above local ground level of all sensitive receptors.
- Screening from any enclosures, barriers, earth berms, buildings, or vegetation.
- Attenuation due to distance (geometrical divergence) and atmospheric absorption.
- Increase in noise level due to reflections from nearby facades and reflective objects.

For the noise assessment of the NorthMet Project Proposed Action, ground topography or surface effects were modeled assuming that the area around the source and the receptors would be a mixed 50 percent hard non-absorptive ground (e.g., paved surfaces, water, ice, concrete, and all other ground surfaces having a low porosity) and 50 percent soft absorptive surface (e.g., ground covered by grass, trees, and farm land, and all other ground surfaces having a high porosity). This is a conservative assumption, as almost 100 percent of the ground adjacent to the mine sound sources and closest receptors is porous with more absorptive capacity that can attenuate noise levels. Temperature and relative humidity of 20 ˚C and 70 percent, respectively, were used in estimating the attenuation due to atmospheric absorption. Attenuation due to geometric divergence or spreading is mainly a function of the distance between the sound source and the receiver. A further conservative assumption is that the modeling analysis did not include any potential shielding effects from pit walls, waste rock stockpiles, berms, or vegetation.

Sound power levels for all equipment and trucks at the Mine Site and Plant Site were based on measured octave-band sound power data obtained from similar mine projects in Australia (Bassett Acoustics 2004; URS 2005). For modeling purposes, it was conservatively assumed that all equipment at the Mine Site and Plant Site would operate continuously.

Noise Impact Assessment Criteria

Noise effects are commonly judged according to two general criteria: the extent to which a project would exceed federal, state, or (where applicable) local noise regulations, and the estimated degree of disturbance to people who live in or use an area.

According to the noise standards for Minnesota (*Minnesota Rules*, part 7030.0040, subpart 2), permissible noise levels are broadly classified according to land uses such as residential, commercial, or industrial. The standards 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 period. The applicable Minnesota Noise Standards are shown in Table 5.2.8-1. Section 4.2.8 provides additional discussion of common noise levels.

Table 5.2.8-1 Applicable Noise Standards for Different Land Uses in Minnesota

Noise Area Classification[1]	Noise Standard (dBA)			
	Daytime (7 a.m. to 10 p.m.)		Nighttime (10 p.m. to 7 a.m.)	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60.0	65.0	50.0	55.0
2	65.0	70.0	65.0	70.0
3	75.0	80.0	75.0	80.0

Source: *Minnesota Rules*, part 7030.0040, subpart 2; MPCA 2008.

[1] The land use activities associated with each NAC are described in Minnesota Rules, part 7030.0040, subpart 2 and MPCA 2008.

- Land use activities under NAC 1 include household units, group quarters, residential hotels, transient lodging camp grounds, correctional institutions, mobile home parks or courts, health and educational services, religious activities, resorts, camping and picnicking areas, motion picture production, and other cultural, entertainment, and recreational activities.
- Land use activities under NAC 2 include rail, road, water, and air transportation activities (passenger), wholesale and retail trade, parks, recreational activities (except entertainment assembly and race tracts), automobile parking, personal services, business services, and other professional services (repair, legal, and contract construction services).
- Land use activities under NAC 3 include manufacturing, petroleum refining and related industries, primary metal industries, race tracks, fair grounds and amusement parks, agricultural and fishing-related activities, retail trade (eating and drinking) and transportation, communication, and utilities (except transportation services and arrangements).

As shown in Table 5.2.8-1, the most stringent standard is the nighttime (10 p.m. to 7 a.m.) standard in a NAC 1, 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 from 10 p.m. to 7 a.m., 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 these same hours, noise levels may not exceed 55 dBA more than 6 minutes in an hour. Land use activities under NAC 1 include household units or private residences, mobile home parks, transient lodging campgrounds and picnic areas, churches, schools, hospitals, and other cultural, entertainment, and recreational activities.

There are no federal or local noise regulations that would apply to the NorthMet Project Proposed Action.

In addition to state and federal 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 NorthMet Project Proposed Action, as well as people who frequent the area for recreation, fishing, and hunting, and tribal members who may be involved in traditional natural resource harvests on national forest lands. 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).

NorthMet Project Proposed Action-related noise effects have been evaluated at sensitive receptors (residential areas) using the state daytime and nighttime noise standards (L_{50} and L_{10}) for residential areas. These noise standards would apply to the NorthMet Project area throughout the years that the mine is operating (years 1 to 20), when elevated sound level activities from mining, hauling, and crushing operations would occur. The same noise standards would also apply to any potential noise source during closure and post-closure (i.e., after year 20).

5.2.8.1.2 Vibration and Airblast

Ground Vibration Impact Assessment Methodology

The ground vibration impact assessment area for the NorthMet Project Proposed Action encompasses a 20-mile radius from the Mine Site. When an explosive is detonated in a blasthole, a pressure wave is generated in the surrounding rock. As this pressure wave moves from the borehole, it forms seismic waves by displacing particles in the earth (e.g., glacial till, bedrock). Ground vibration varies with distance from the blast, charge mass per hole, type of explosive, geological conditions, and blasting specifications. For similar geological conditions and blasting specifications, ground vibration varies with distance from the blast and charge mass per hole, according to the Site Law formula. This formula has been used for assessing ground vibration effects from blasting activities at multiple mine and quarry sites in Australia and has also been used in this assessment. The formula accounts for different rock types with a site constant K_g (see note in Table 5.2.8-4 for definition of K_g). Typical K_g factors for free-face hard or highly structured rock, free-face average rock, and heavily confined rock are 500, 1,140, and 5,000, respectively (Dyno Nobel 2010). This vibration assessment has been conducted using a range of these three K_g factors to allow for varying degrees of vibration transmission through different rock types.

Airblast Overpressures Impact Assessment Methodology

The impact assessment area for airblast overpressure for the NorthMet Project Proposed Action is the same area that was used to evaluate ground vibration. An airblast is an airborne shock wave that results from the detonation of explosives. The magnitude of airblast overpressure levels at a point remote from the blast is a function of many parameters including charge mass (mass of explosive per drilled hole), confinement, burden (distance between two drilled holes and perpendicular to the free face), attenuation rate, shielding direction relative to the blast, and meteorological conditions at the time of the blast. The attenuation rate for low-frequency blast vibration has been found from experience to be a 9 dBL reduction per doubling of distance (Terrock Consulting Engineers 2009).

Analysis of blasting data from mines and quarries has permitted a relationship to be established between the maximum 120 dBL distance (the distance in front of the blast that the 120 dBL contour occurs), charge mass per hole, and burden using the Terrock model. This model has been used for assessing airblast effects from blasting activities at multiple mine and quarry sites in Australia and has also been used in this assessment. The model accounts for a dimensionless empirical constant, k_a (usually 250 for quarry and mine blasting), and determines the maximum distance to the 120 dBL contour from the blast site.

Ground Vibration and Airblast Overpressure Evaluation Criteria

Humans can feel ground vibration and airblast overpressures at levels well below those that can cause damage to property. Ground vibration and airblast overpressure limits, therefore, have two aspects: an environmental or acceptable human response (annoyance) limit, and a limit to prevent structural damage (which should be considered separately).

To minimize human annoyance and prevent structural damage to properties outside mining areas, the effects of ground vibration and air overpressure from blasting operations must meet the requirements of *Minnesota Rules*, part 6132.2900, subpart 2. According to the *Minnesota Rules*, the maximum PPV from blasting should not exceed 1 in/s (25.4 mm/s) at the location of a structure located on lands not owned or controlled by the permittee. Air overpressure on lands not owned or controlled by the permittee should not exceed 130 dB, as measured on a linear peak scale (dBL) sensitive to a frequency band ranging from 6 cycles per second to 200 cycles per second.

Ground vibration and air blast (overpressure) from rock blasting are primarily related to the weight of explosive detonated at any single instant and the distance to a structure or sensitive receptor.

Aside from the *Minnesota Rules*, there are no specific federal or local vibration regulations associated with mine blasting that would apply to the NorthMet Project Proposed Action.

5.2.8.2 NorthMet Project Proposed Action

5.2.8.2.1 Noise

The primary sources of noise from the Mine Site (3,014.5 acres) during operations would be drilling; blasting; excavation work (hydraulic excavators, front-end loaders); dump trucks hauling material along mine haul roads; material-handling activities at the Rail Transfer Hopper, Overburden Storage and Laydown Area, and Waste Rock Stockpiles; and train horns. Noise would also be generated from auxiliary and support equipment such as tracked dozers, wheel dozers, graders, water trucks, backhoes, and fuel trucks. The sound power levels for each of these sources, based on data from operating mines, are summarized in Table 5.2.8-2.

Table 5.2.8-2 Maximum Sound Power Levels of Major Equipment and Trucks during Operations at the Mine Site and Plant Site

Noise Source Description	Octave Band Center Frequency (Hz)								Overall Linear-Weighted Sound Power Level (dBL)	Overall A-Weighted Sound Power Level (dBA)
	63.0	**125.0**	**250.0**	**500.0**	**1000.0**	**2000.0**	**4000.0**	**8000.0**		
Mine Site										
Rotary Drill Rig	110.0	123.0	114.0	119.0	111.0	109.0	103.0	98.0	125.0	119.0
Hydraulic Excavator (31-cy)	111.0	122.0	118.0	117.0	115.0	110.0	104.0	99.0	125.0	119.0
Hydraulic Excavator (31-cy)	111.0	122.0	118.0	117.0	115.0	110.0	104.0	99.0	125.0	119.0
Hydraulic Excavator (31-cy)	111.0	122.0	118.0	117.0	115.0	110.0	104.0	99.0	125.0	119.0
Front-end Loader (21.5-cy)	112.0	111.0	112.0	114.0	112.0	112.0	106.0	101.0	120.0	117.0
Tracked Dozer (582-hp)	118.0	118.0	104.0	100.0	104.0	102.0	97.0	92.0	121.0	109.0
Tracked Dozer (582-hp)	118.0	118.0	104.0	100.0	104.0	102.0	97.0	92.0	121.0	109.0
Wheel Dozer (450-hp)	117.0	123.0	119.0	111.0	107.0	101.0	91.0	83.0	125.0	115.0

Noise Source Description	Octave Band Center Frequency (Hz) 63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0	Overall Linear-Weighted Sound Power Level (dBL)	Overall A-Weighted Sound Power Level (dBA)
Mine Site										
Grader (275-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Grader (275-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Water Truck (937-hp)	107.0	110.0	116.0	114.0	109.0	107.0	101.0	102.0	120.0	116.0
Water Truck (937-hp)	107.0	110.0	116.0	114.0	109.0	107.0	101.0	102.0	120.0	116.0
Wheel Loader (800-hp)	112.0	111.0	112.0	114.0	112.0	112.0	106	101.0	120.0	117.0
Backhoe (110-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Fuel Truck (150-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Fuel Truck (150-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Total Sound Power Level from all equipment at the Mine Site	125.0	131.0	128.0	128.0	128.0	127.0	121.0	113.0	136.0	133.0
Plant Site										
Primary Crusher	123.0	123.0	121.0	111.0	106.0	105.0	100.0	94.0	127.0	116.0

1. Assumes all mine equipment and trucks would be in continuous operation at any given time at the Mine Site.
2. Sound power levels for all equipment and trucks at the Mine Site were taken from the *Noise and Vibration Assessment for the Clermont Coal Mine Project, Queensland Australia, August 2004* (Bassett Acoustics 2004). Sound power levels for backhoe and fuel trucks were not available and were assumed to be the same as for the graders due to their similar hp ratings.
3. Sound power levels for the primary crusher at the Plant Site (116 dBA) were taken from the McArthur River Mine Open Cut Project, Australia (URS 2005).
4. All mine and plant equipment were assumed to be approximately 5 meters from ground level.

5. Total sound power level from all equipment at the Mine Site was calculated by logarithmically adding all the octave-band sound power levels for each piece of equipment at the site.

To estimate potential noise effects on closest receptors, noise from proposed mine operations was modeled using the ISO 9613-2 sound-propagation model, as described in Section 5.2.8.1. The Mine Site assessment predicted effects at nine different receptor locations scattered throughout the vicinity of the site. The closest noise-sensitive areas to the Mine Site are shown on Figure 4.2.8-1; the closest of these is the City of Babbitt, located 6.5 miles north of the Mine Site. All major mine equipment and trucks shown in Table 5.2.8-2 were assumed to be operating simultaneously. Modeled sound levels from all mine equipment and trucks experienced at the nearest receptors during daytime and nighttime mine operations, plus baseline levels (excluding plant sources), are shown in Table 5.2.8-3.

Table 5.2.8-3 Predicted Noise Levels at Nearest Receptors to Mining and Hauling Operations at Mine Site (includes Baseline Levels)

	Distance to Mine Site (miles)[2]		Daytime Noise Levels at Closest Receptors to Mine Site (plus Baseline Levels)[1] (dBA)			Nighttime Noise Levels at Closest Receptors to Mine Site (plus Baseline Levels)[1] (dBA)		
Receptor	**Distance**	**Direction**	L_{eq}	L_{50}	L_{10}	L_{eq}	L_{50}	L_{10}
Private Residences (R-1)	8.4	NW	45.7	44.7	49.4	39.6	38.6	42.4
Hoyt Lakes (R-2)	10.3	SW	45.5	44.4	49.2	38.2	37.2	41.0
Boy Scout Camp (R-3)	12.3	SW	45.3	44.3	49.0	37.3	36.3	40.1
Babbitt (R-4)	6.5	N	46.3	45.3	49.9	41.5	40.5	44.3
Skibo (R-5)	9.1	S	45.6	44.6	49.3	39.0	38.0	41.8
Aurora (R-6)	13.8	SW	45.2	44.2	49.0	36.8	35.8	39.6
Ely (R-7)	20.4	N-NE	45.1	44.1	48.9	35.7	34.7	38.5
BWCA Wilderness (R-8)	21.9	N	40.2	39.2	43.0	31.5	30.5	34.3
Tower (R-9)	19.3	NW	45.1	44.1	48.9	35.8	34.8	38.6

[1] Summary of assumed baseline noise levels (literature values; USEPA 1974) at the closest receptors to the Mine Site can be found in Table 4.2.8-3.
[2] N=North, S=South, E=East, W=West, NW=Northwest, NE=Northeast, SW=Southwest,

Table 5.2.8-3 indicates that the highest noise levels that would be experienced during operations at the Mine Site would occur at the closest receptors in Babbitt. The L_{50} and L_{10} nighttime noise levels, when combined with the baseline levels, are 40.5 and 44.3 dBA, respectively. The predicted L_{eq} at noise-sensitive receptors around the Mine Site were converted to L_{50} and L_{10} using a USEPA calculation methodology (USEPA 1974). The calculation was based on an assumed standard deviation of 3 dBA for sound level distribution.

The total combined effect of baseline levels plus noise from operations at the Mine Site, Transportation and Utility Corridor, and Plant Site are discussed in Section 5.2.8.2.3.

The primary sources of noise along the Transportation and Utility Corridor would be trains and train horns used during ore transport from the Mine Site to the Plant Site. The noise from the trains and their horns is expected to have minimal effects because the railroad route between the two locations is approximately 4 to 5 miles from the nearest receptors. Up to 22 trains per day are expected to deliver ore to the Plant Site. This frequency of traffic is less than that experienced on the rail line during past mining operations.

The primary sources of noise from the Plant Site would be crushers. The sound power level for the crushers was estimated to be 116 dBA (Table 5.2.8-2). Sound-propagation modeling was performed for the crushers using the ISO 9613-2 sound-propagation model and assumptions described in Section 5.2.8.1. Modeled sound levels experienced at the nearest receptors during ore-crushing operations, plus baseline levels (excluding mine sources), are shown in Table 5.2.8-4.

Table 5.2.8-4 Predicted Noise Levels at Nearest Receptors to Ore-crushing Operations at Plant Site (includes Baseline Levels)

	Distance to Mine Site (miles)[2]		Daytime Noise Levels at Closest Receptors to Plant Site (plus Baseline Levels)[1] (dBA)			Nighttime Noise Levels at Closest Receptors to Plant Site (plus Baseline Levels)[1] (dBA)		
Receptor	**Distance**	**Direction**	**L_{eq}**	**L_{50}**	**L_{10}**	**L_{eq}**	**L_{50}**	**L_{10}**
Private Residences (R-1)	4.2	N	46.6	45.6	50.1	42.3	41.2	45.1
Hoyt Lakes (R-2)	5.6	S	45.9	44.9	49.5	40.1	39.0	42.9
Boy Scout Camp (R-3)	6.5	S	45.6	44.6	49.3	39.1	38.1	41.9
Babbitt (R-4)	11.8	NE	45.2	44.2	48.9	36.4	35.4	39.2
Skibo (R-5)	10.5	SE	45.2	44.2	49.0	36.8	35.8	39.6
Aurora (R-6)	6.7	SW	45.6	44.6	49.3	39.0	38.0	41.8
Ely (R-7)	24.4	NE	45.0	44.0	48.8	35.2	34.2	38.0
BWCA Wilderness (R-8)	23.0	N	40.1	39.1	42.9	30.8	29.8	33.6
Tower (R-9)	15.4	NW	45.1	44.1	48.9	35.8	34.8	38.6

1 Summary of assumed baseline noise levels (literature values, USEPA 1974) at the closest receptors to the Plant Site can be found in Table 4.2.8-3.
2 N=North, S=South, NW=Northwest, NE=Northeast, SW=Southwest, SE=Southeast

Table 5.2.8-4 indicates the highest nighttime L_{50} and L_{10} levels that would be experienced at the closest receptor (private residences, 4.2 miles north of the Plant Site) due to operations at the Plant Site are 41.2 and 45.1 dBA, respectively, inclusive of baseline levels. The total combined noise effect from operations at the Mine Site, Transportation and Utility Corridor, and Plant Site, plus baseline levels, is discussed in Section 5.2.8.2.3.

5.2.8.2.2 Ground Vibration and Airblast Overpressure

The potential for ground vibration from hauling material via dump trucks along the mine haul road is expected to be low since rubber-tired vehicles do not generate any significant amount of ground vibration. However, blasting at the Mine Site could affect surrounding residential receptors and structures or buildings with regard to ground vibration and airblast overpressure. The potential effects of ground vibration and airblast overpressure are discussed below.

Ground Vibration from Blasting at the Mine Site

Except at very close distances to a blast, when permanent ground displacement could occur, ground vibration is an elastic wave motion and the ground returns to its original position after the wave passes. The attenuation rate varies based on the characteristics of the rock through which the vibration travels. Characteristics such as faults and jointing planes, degree and depth of weathering, and the top soil profile contribute to a wide variation of vibration levels.

The potential effect of ground vibration from blasting at the Mine Site was assessed using the Site Law formula, as described in Section 5.2.8.1. The vibration assessment was conducted over a range of K_g factors that represent the vibration transmission through different types of ore or waste rock. Using the Site Law formula and appropriate blast parameters, the limiting distances (i.e., distances beyond which an effect would not occur using different K_g factors) for ore and waste rock blasts at ground vibration levels ranging from 0.5 to 25.4 mm/s were calculated and are shown in Table 5.2.8-5. Ground vibration contours from blasting at the Mine Site are shown on Figure 5.2.8-1 (based on a maximum K_g factor of 5,000 for heavily confined rocks).

Table 5.2.8-5 Limiting Distances for Ore and Waste Rock Blasts at Incremental Ground Vibration Levels

Ground Vibration, PPV	**Limiting Distance from Blast, D (m)[1]**		
(mm/sec)	k_g = 500	k_g = 1,140	k_g = 5,000
25.4	375	627	1,581
20	435	728	1,835
15	521	872	2,197
10	671	1,123	2,830
5	1,035	1,733	4,365
3	1,424	2,384	6,007
1	2,830	4,738	11,936
0.5	4,365	7,306	18,407

Notes:
kg = Site specific empirical constant for predicting ground vibration levels (dimensionless). Usually determined by site calibration. Typical Kg factors for free face hard /highly structured rock, free face average rock, and heavily confined rock are 500, 1140, and 5000, respectively.
[1] Limiting distances for predicting ground vibration levels from blasting were estimated based on the charge mass per hole (3,388 kg/hole). The charge mass per hole was estimated using the blast parameters and specification for this project such as blasthole diameter (311 mm), hole length (22.6 m), burden (8.84 m), spacing (10.1 m), and explosive density (1.69 kg/m3).

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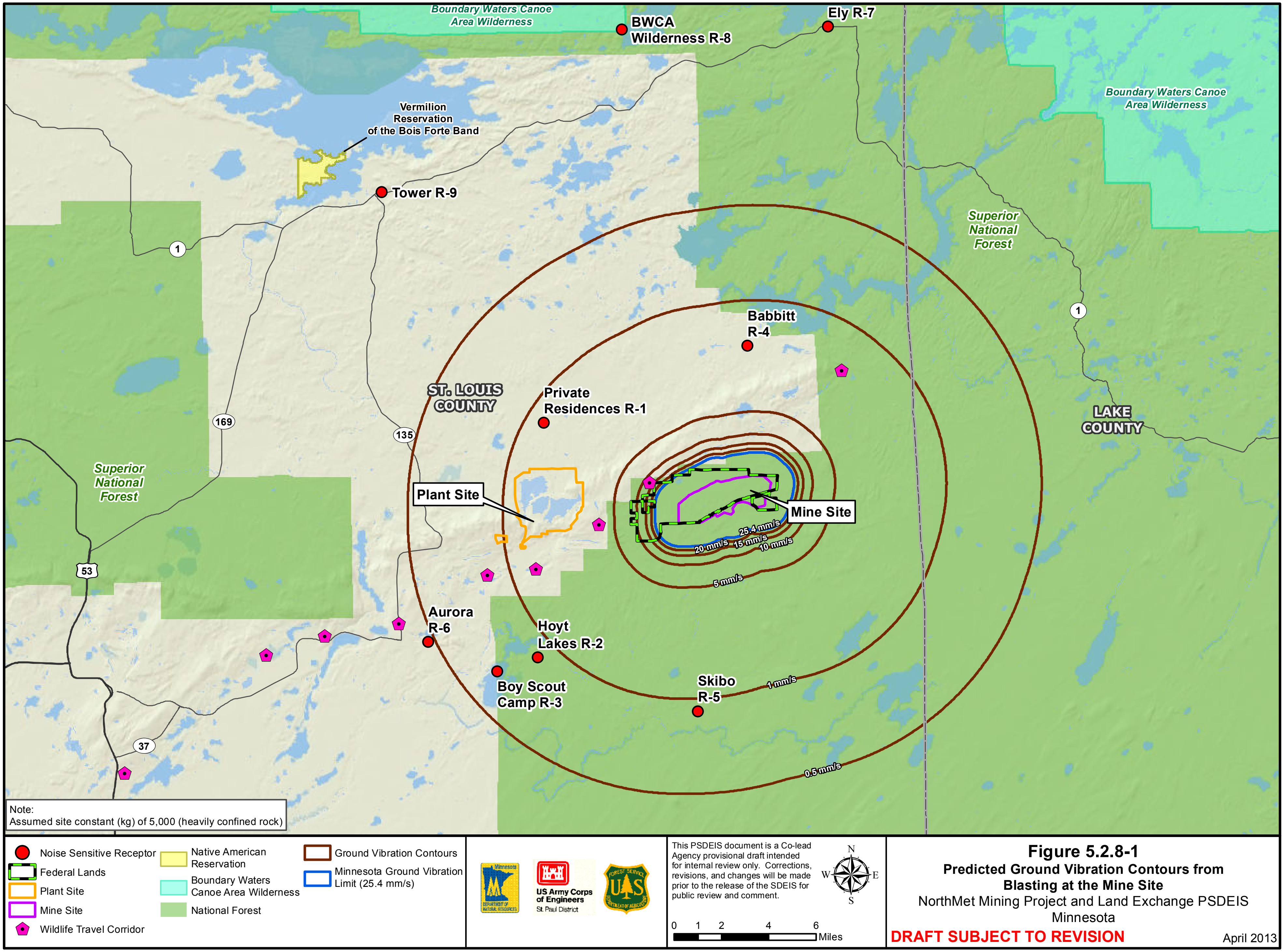

Figure 5.2.8-1
Predicted Ground Vibration Contours from Blasting at the Mine Site
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The environmental effects of blasting at non-ferrous mining operations are regulated by the MDNR to ensure that the effects of ground vibrations from production blasts would not be detrimental to human health or welfare or property outside the mining area. According to *Minnesota Rules*, part 6132.2900, subpart 2, the maximum PPV from blasting shall not exceed 1 in/s (25.4 mm/s) at the location of a structure located on lands not owned or controlled by the permittee. Assuming a worst-case K_g of 5,000 (heavily confined rocks) and 3,388 kg (7,471 lbs) of explosives per blast hole, the limiting distance for blasts at ground vibration levels of 25.4 mm/s (1 in/s) is 1,581 meters (0.98 miles) (Table 5.2.8-5; Figure 5.2.8-1). None of the residential areas are located within this radius. The maximum ground vibration level for the closest receptor in the City of Babbitt, 6.5 miles north of the Mine Site, from the blast site is predicted to be on the order of 1.24 mm/s (0.05 in/s). The predicted ground vibration at all nearby receptors resulting from blasting at the Mine Site would be well below the applicable limits in Minnesota. Blasting would not occur at night.

As noted previously, the use of the Superior National Forest lands within the Mine Site for recreational activities is infrequent. To the extent that this activity occurs, people who recreate within a 0.98-mile radius of the Mine Site may experience ground vibration levels close to the Minnesota standards.

Based on the information above, ground vibration levels from mine blasting are expected to be below the Minnesota ground vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2); however, people that recreate within a 0.98-mile radius of the Mine Site could experience ground vibration levels close to or exceeding the Minnesota standards. Recommended ground vibration mitigation measures for people that recreate near the Mine Site during blasting operations are listed in Section 5.2.8.2.4.

During the closure and post-closure phases (i.e., after year 20), blasting at the Mine Site would cease, so no blast-related ground vibration would occur. Machinery, such as planters used to restore and rehabilitate the Mine Site during the closure phase, would not generate a significant amount of ground vibration. Therefore, potential ground vibration levels during the closure and post-closure phases are expected to be below the Minnesota ground vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2).

Airblast Overpressure from Blasting at the Mine Site

The airblast overpressure effect from the Mine Site was assessed using the Terrock model, as described in Section 5.2.8.1. Using this analytical method for ore and/or waste rock blasts at the Mine Site, the 120 dBL distance for the assumed blast specifications is a maximum of 3,451 meters (2.2 miles) in front of the blast (Table 5.2.8-6). The incremental distances for airblast overpressure levels from 100 to 130 dBL were calculated using an attenuation rate of a 9 dBL decrease per doubling of distance (Terrock Consulting Engineers 2009). Airblast contours for these overpressure levels from blasting at the Mine Site are shown on Figure 5.2.8-2.

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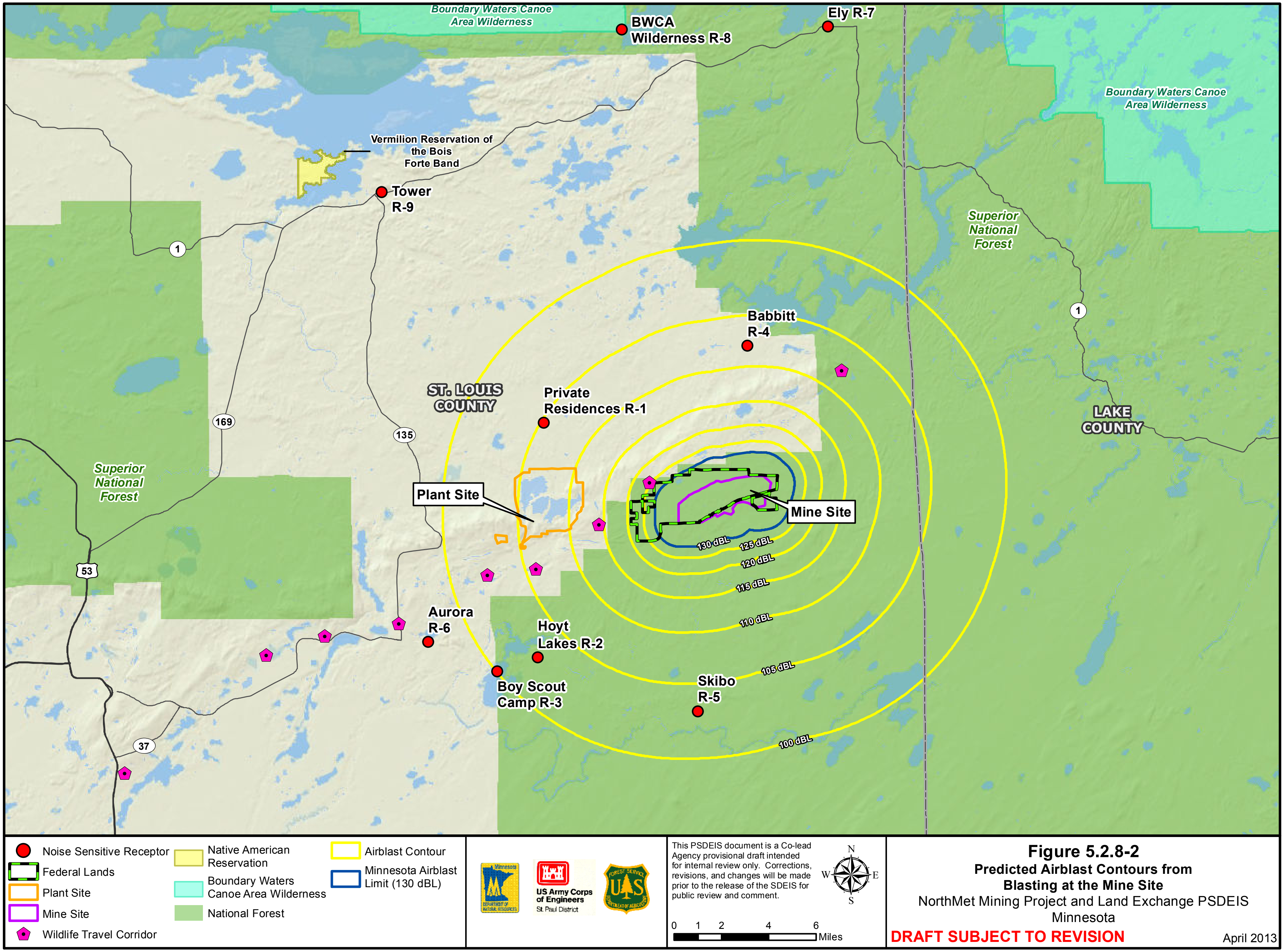

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Figure 5.2.8-2
Predicted Airblast Contours from Blasting at the Mine Site
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Table 5.2.8-6 Limiting Distances for Ore and Waste Rock Blasts at Incremental Airblast Overpressure Levels

Hole Diameter, d (mm)	Burden, B (mm)	Charge Mass per Hole, M (kg/hole)	Distance to the 120 dBL Contour, D_{120} (m)	Distance to the 130 dBL Contour, D_{130} (m)	Distance to the 125 dBL Contour, D_{125} (m)	Distance to the 115 dBL Contour, D_{115} (m)	Distance to the 110 dBL Contour, D_{110} (m)	Distance to the 105 dBL Contour, D_{105} (m)	Distance to the 100 dBL Contour, D_{100} (m)
311	8,839	3,388	3,451	1,602	2,351	5,065	7,434	10,912	16,016

Note: Based on the computed distance for the 120 dBL contours, the distances for the other airblast contour levels (130 dBL, 125 dBL, 115 dBL, 110 dBL, 105 dBL, and 100 dBL) were calculated using an attenuation rate of 9 dBL decrease per doubling of distance.

As with ground vibration, the environmental effects of airblasts are regulated by the MDNR. According to *Minnesota Rules*, part 6132.2900, subpart 2, air overpressure on lands not owned or controlled by the permittee shall not exceed 130 dBL. The distance from the Mine Site to the 130 dBL compliance level is 1,602 meters (1 mile). None of the receptors (buildings or structures) is close enough to the Mine Site to achieve this level of exposure (Figure 5.2.8-2). The maximum airblast overpressure level for the closest receptor in the City of Babbitt is predicted to be 105.6 dBL. The predicted airblast overpressures at all nearby receptors resulting from blasting activities at the Mine Site would be below the applicable limits in Minnesota. Blasting would not occur at night.

Based on the information above, airblast overpressure levels from mine blasting would be below the Minnesota airblast standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2); however, people that recreate within a 1-mile radius of the Mine Site could experience airblast levels close to the Minnesota standards. Recommended airblast mitigation measures for people that recreate near the Mine Site during blasting operations are listed in Section 5.2.8.2.4.

During the closure and post-closure phases (i.e., after year 20), blasting at the Mine Site would cease, so no airblast overpressures would occur during the closure and post-closure phases.

Vibration and Airblast Overpressure from Rail Transport

The transport of ore via trains from the Mine Site to the Plant Site could generate ground vibration within a few feet of the rail ROW, but due to the low volume of trains, such vibration levels are expected to be below the Minnesota ground vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2). No blasting would occur along the Transportation and Utility Corridor, so ground vibration or airblast overpressure effects are not expected in this area.

Vibration and Airblast Overpressure at Plant Site

The crushers, water pumps (near the Tailings Basin) and other large stationary equipment that would be located at the Plant Site are designed to ensure that potential ground vibration effects are minimized to acceptable levels. Therefore, during operation, vibration levels at the receptors closest to the Plant Site would be below the Minnesota vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2). No blasting would occur at the Plant Site, so ground vibration or airblast overpressure effects are not expected.

5.2.8.2.3 Total Noise Effects from NorthMet Project Proposed Action Operations

To determine the combined noise effect of the NorthMet Project Proposed Action, the total noise generated from operations at both the Mine Site and Plant Site was logarithmically added to the existing ambient daytime and nighttime baseline levels. Noise effects from rail transport were also assessed, but qualitatively.

Operations at the Mine Site and Plant Site would occur 24 hours per day. The total noise that would be experienced at any receptor location during the daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) would be equal to the combined noise from both the mining and hauling operations at the Mine Site and the ore-crushing operations at the Plant Site, plus baseline noise levels.

Decibels are logarithmic values, so calculating the additive effect of two separate noise sources is a logarithmic calculation rather than an algebraic addition. This means that individual sound levels cannot be added directly to get the combined sound level. This also means that the greater the distance between two sound levels, the smaller the effect the lesser dB level will have on the total sound level.

The total noise associated with NorthMet Project Proposed Action operations when mining, hauling, and ore-crushing operations occur concurrently was calculated using data from Tables 5.2.8-3 (Mine Site) and 5.2.8-4 (Plant Site), along with assumed literature values for baseline noise levels, and is summarized in Table 5.2.8-7. The calculations for daytime and nighttime noise levels are presented for comparison with the Minnesota noise standards. In all cases, the NorthMet Project Proposed Action, when in operation, would comply with the applicable standard. Figures 5.2.8-3, 5.2.8-4, 5.2.8-5, and 5.2.8-6 show L_{50} and L_{10} noise contours at 5 dBA intervals during the daytime and nighttime.

Table 5.2.8-7 Total Noise Associated with Concurrent Operations at the Mine Site and Plant Site (includes Baseline Levels)

Receptor	Daytime and Nighttime Baseline Noise Levels (dBA)			Daytime Noise Levels at Closest Receptors to Mine Site and Plant Site Operations (plus Baseline Levels)[1], (dBA)			Nighttime Noise Levels at Closest Receptors to Mine Site and Plant Site Operations (plus Baseline Levels), (dBA)			Minnesota Daytime and Nighttime Noise Standards for Residential Areas (dBA)		
	L_{eq}	L_{50}	L_{10}	L_{eq}	L_{50}	L_{10}	L_{eq}	L_{50}	L_{10}	L_{eq}	L_{50}	L_{10}
Private Residences (R-1)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	47.1	46.1	50.5	43.6	42.5	46.4	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Hoyt Lakes (R-2)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	46.2	45.2	49.8	41.3	40.3	44.1	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Boy Scout Camp (R-3)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.9	44.9	49.5	40.1	39.1	42.9	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Babbitt (R-4)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	46.4	45.4	50.0	41.9	40.9	44.7	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Skibo (R-5)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.8	44.8	49.4	39.8	38.8	42.6	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Aurora (R-6)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.8	44.8	49.4	39.8	38.8	42.6	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Ely (R-7)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.1	44.1	48.9	35.9	34.9	38.7	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
BWCA Wilderness (R-8)	40.0 dBA (D); 30.0 dBA (N)	39.0 dBA (D); 29.0 dBA (N)	42.8 dBA (D); 32.8 dBA (N)	40.3	39.3	43.1	32.1	31.1	34.9	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Tower (R-9)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.2	44.2	48.9	36.4	35.4	39.2	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)

Notes:

D= Daytime; N = Nighttime; NA = Not applicable (there are no L_{eq} standards for noise under the Minnesota Noise Standards).

[1] Total noise levels during daytime and nighttime were estimated by logarithmically adding the predicted noise levels from operations at the Mine Site (Table 5.2.8-3) and Plant Site (Table 5.2.8-4) with the existing baseline noise levels (baseline levels were taken from USEPA 1974, as shown in Table 4.2.8-2).

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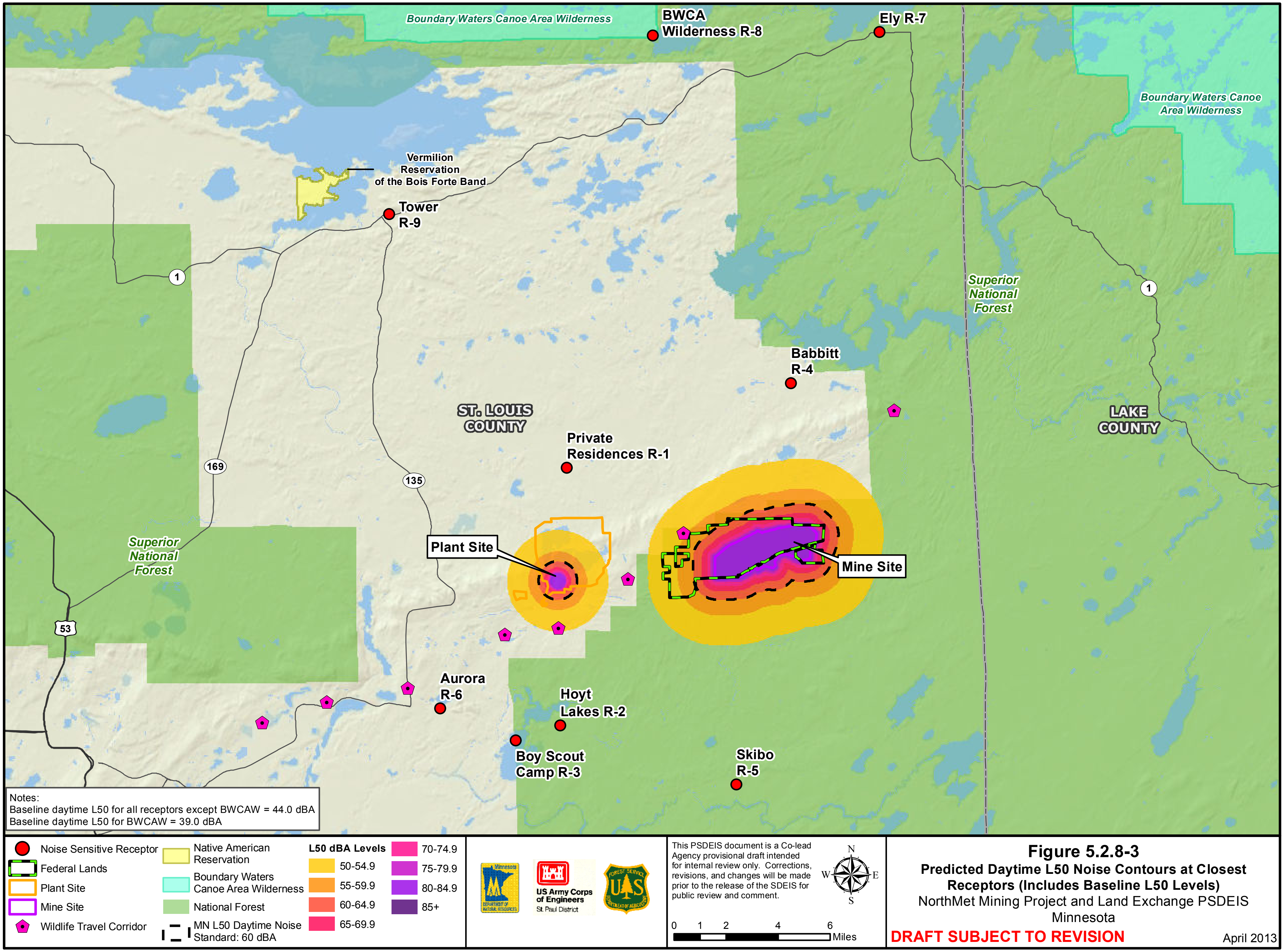

Figure 5.2.8-3
Predicted Daytime L50 Noise Contours at Closest Receptors (Includes Baseline L50 Levels)
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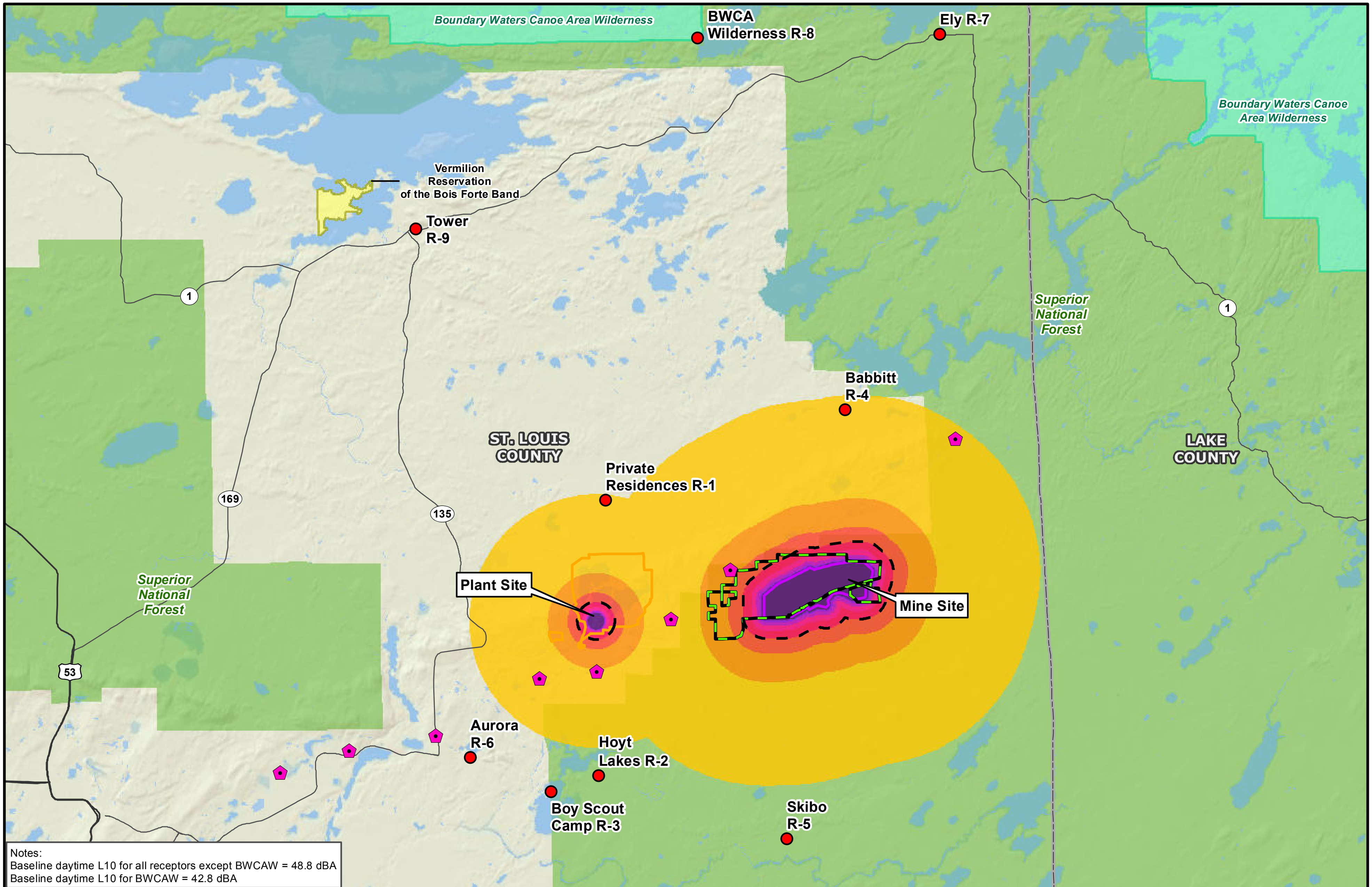

Noise Sensitive Receptor
Federal Lands
Plant Site
Mine Site
Wildlife Travel Corridor
Native American Reservation
Boundary Waters Canoe Area Wilderness
National Forest
MN L10 Daytime Noise Standard: 65 dBA

L10 dBA Levels
50-54.9
55-59.9
60-64.9
65-69.9
70-74.9
75-79.9
80-84.9
85+

US Army Corps of Engineers St. Paul District

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N W E S

0 1 2 4 6 Miles

Figure 5.2.8-4
Predicted Daytime L10 Noise Contours at Closest Receptors (Includes Baseline L10 Levels)
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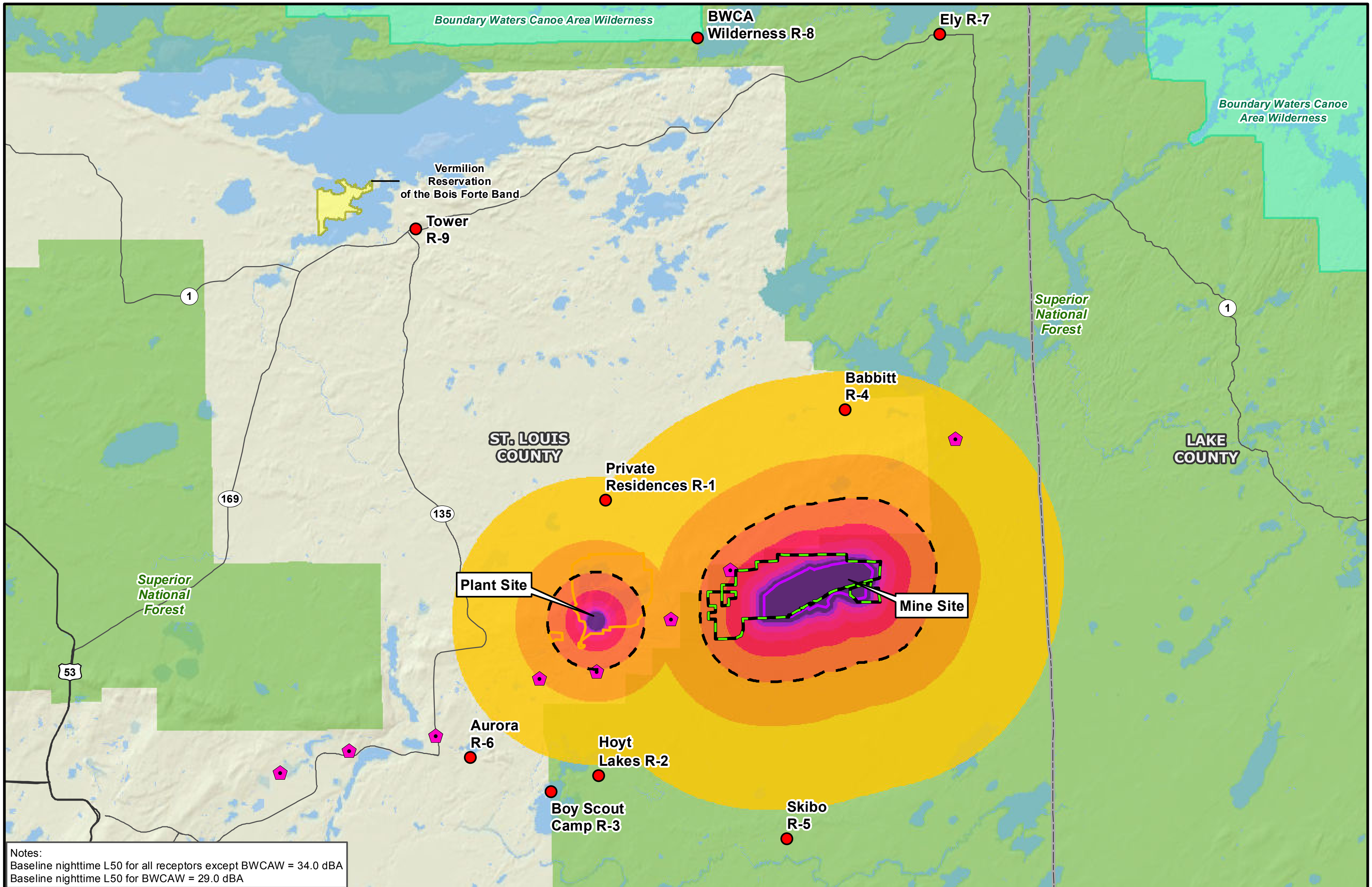

Noise Sensitive Receptor
Federal Lands
Plant Site
Mine Site
Wildlife Travel Corridor
Native American Reservation
Boundary Waters Canoe Area Wilderness
National Forest
MN L50 Nighttime Noise Standard: 50 dBA

L50 dBA Levels
40-44.9
45-49.9
50-54.9
55-59.9
60-64.9
65-69.9
70-74.9
75+

US Army Corps of Engineers
St. Paul District

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N W E S

0 1 2 4 6 Miles

Figure 5.2.8-5
Predicted Nighttime L50 Noise Contours at Closest Receptors (Includes Baseline L50 Levels)
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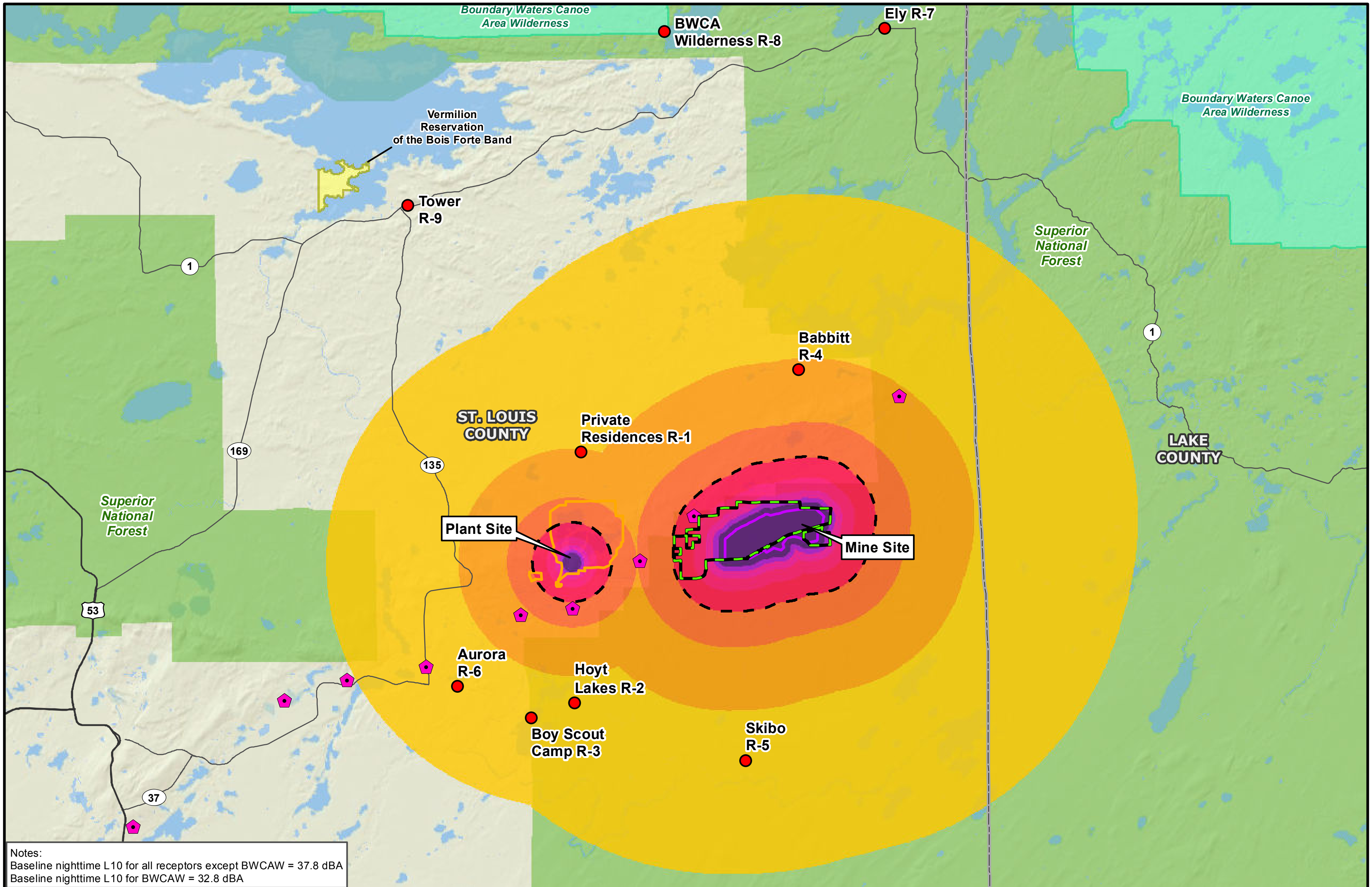

Noise Sensitive Receptor	Native American Reservation	**L10 dBA Levels**		60-64.9
Federal Lands	Boundary Waters Canoe Area Wilderness	40-44.9		65-69.9
Plant Site	National Forest	45-49.9		70-74.9
Mine Site	MN L10 Nighttime Noise Standard: 55 dBA	50-54.9		75+
Wildlife Travel Corridor		55-59.9		

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

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N E S W

0 1 2 4 6 Miles

Figure 5.2.8-6
Predicted Nighttime L10 Noise Contours at Closest Receptors (Includes Baseline L10 Levels)
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Daytime Operations (7 a.m. to 10 p.m.)

Table 5.2.8-7 and Figures 5.2.8-3 and 5.2.8-4 present the total estimated daytime L_{50} and L_{10} levels that would be experienced at the closest receptors to the Mine Site and Plant Site. Noise from Mine Site and Plant Site operations, plus baseline levels, are predicted to be well below the Minnesota daytime noise standards of 60 dBA (L_{50}) and 65 dBA (L_{10}) for residential areas. As an example of how the total noise level is calculated, the L_{50} daytime level of 46.1 dBA for private residences shown in Table 5.2.8.7 is the result of adding 36.7 dBA (daytime L_{50} levels from Mine Site operations only, excluding Plant Site operations and baseline levels), 40.3 dBA (daytime L_{50} levels from Plant Site operations only, excluding Mine Site operations and baseline levels), and 44 dBA, which is the assumed daytime L_{50} baseline level. Figure 5.2.8-3 shows that the daytime L_{50} standard for residential areas would not be reached beyond 0.84 mile and 0.47 mile from the Mine Site and Plant Site, respectively. Similarly, Figure 5.2.8-4 shows that the daytime L_{10} standard for residential areas would not be reached beyond 0.75 mile and 0.41 mile from the Mine Site and Plant Site, respectively. Residential areas and other sensitive receptors are well outside these distances. The highest daytime noise levels, including baseline levels, predicted for the closest receptor to the Mine Site (i.e., Babbitt (R-4)) were 45.4 dBA (L_{50}) and 50.0 dB (L_{10}). The daytime noise effect of the Mine Site on Babbitt is an increase of 1.4 dBA (L_{50}) and 1.2 dBA (L_{10}) from baseline levels. Similarly, the highest daytime noise levels, including baseline levels, predicted for the closest receptor to the Plant Site (i.e., Private Residences (R-1)) were 46.1 dBA (L_{50}) and 50.5 dBA(L_{10}). The daytime noise effect of the Plant Site on the private residences is an increase of 2.1 dBA (L_{50}) and 1.7 dBA (L_{10}) from baseline levels. This is below the 3 dBA threshold of perception per the MCPA's *Guide to Noise Control in Minnesota* and would not be perceptible to residents (MPCA 2008).

As discussed earlier, noise from trains and train horns during ore transportation during the day from the Mine Site to the Plant Site is expected to be minimal because the railroad route between the two is approximately 4 to 5 miles from the nearest receptors. Up to 22 trains per day are expected to deliver ore to the Plant Site. This frequency of traffic is less than that experienced on the rail line during past mining operations.

Blasting at the Mine Site is a source of impulsive or non-continuous noise. Blasting noise is not included in the noise level estimates shown in Table 5.2.8-7 because mine-blasting is typically an instantaneous 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. Rock-blasting could potentially have noise levels ranging from 111 to 115 dBA at 50 feet from the blasting site. With modern blasting techniques, the blasting would be experienced by the nearest 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. The closest receptor (City of Babbitt) is located 6.5 miles from the Mine Site, so noise effects from blasting are not expected to be significant. In addition, noise effects from blasting would only occur during the early stages of mining, when blasting occurs at the surface down to a few feet below ground levels. As the depth of the pit increases over the life of the mine, noise effects from blasting would be attenuated by the pit walls.

The Superior National Forest is used for dispersed types of recreation such as hiking, hunting, and bird watching. The use of the Superior National Forest lands for these recreational activities, however, is infrequent because of the wet topography and lack of developed recreation sites and access roads. As discussed above, the daytime L_{50} and L_{10} standards for sensitive receptors would not be reached beyond 0.84 mile of the Mine Site and 0.47 mile of the Plant Site. The actual location of recreational activities near the NorthMet Project area (within the Superior National Forest) is unknown, but people that recreate within an 0.84-mile radius of the Mine Site and 0.47-mile radius of the Plant Site could experience noise levels that were close to or exceeded the Minnesota daytime noise standards.

Nighttime Operations (10 p.m. to 7 a.m.)

Table 5.2.8-7 and Figures 5.2.8-5 and 5.2.8-6 indicate that the total estimated nighttime L_{50} and L_{10} levels that would be experienced at the receptors closest to the Mine Site and Plant Site are expected to be below the Minnesota nighttime noise standards of 50 dBA (L_{50}) and 55 dBA (L_{10}) for residential areas. Figure 5.2.8-5 shows that the nighttime L_{50} standard for residential areas would not be reached beyond 2.3 miles and 1.5 miles from the Mine Site and Plant Site, respectively. Similarly, Figure 5.2.8-6 shows that the nighttime L_{10} standard for residential areas would not be reached beyond 2.1 miles and 1.3 miles from the Mine Site and Plant Site, respectively. Residential areas and other sensitive receptors are well outside these distances. As previously discussed, use of the Superior National Forest lands for recreational activities such as hiking, hunting, and bird watching is infrequent. The potential for recreational activities near the NorthMet Project area during nighttime hours is very low, so there are not expected to be noise effects on nighttime recreational activities within the Superior National Forest.

Mine-blasting and ore transportation via trains along the Transportation and Utility Corridor would not occur between 10 p.m. and 7 a.m., so there would not be noise effects associated with these activities at night.

The highest nighttime L_{50} and L_{10} levels, including baseline levels, predicted for the closest receptor to the Mine Site (i.e., Babbitt (R-4)) were 40.9 dBA and 44.7 dBA, respectively. The nighttime noise effect of Mine Site operations on Babbitt is an increase of 6.9 dBA (L_{50}) and 6.9 dBA (L_{10}) from baseline levels. Similarly, the highest nighttime L_{50} and L_{10} levels, including baseline levels, predicted for the closest receptor to the Plant Site (i.e., Private Residences (R-1)) were 42.5 dBA and 46.4 dBA, respectively. The nighttime noise effect of the Plant Site on the Private Residences is an increase of 8.5 dBA (L_{50}) and 8.6 dBA (L_{10}) from baseline levels. This increase of 6.9 dBA to 8.6 dBA would be perceptible and could cause annoyance because it exceeds the 3 dBA threshold of perception noted in the MCPA guidance (MPCA 2008). It should be noted that the noise model conservatively assumes that all mine equipment shown in Table 5.2.8-2 would be operating simultaneously during daytime and nighttime. Under actual conditions, the predicted noise levels would be lower because not all equipment would be operating simultaneously and some equipment would not operate at all during nighttime.

Based on the information above, the total predicted nighttime noise (L_{50} and L_{10}) level experienced at the closest residential areas (the City of Babbitt north of the Mine Site, and private residences located north of the Plant Site) would meet the Minnesota noise standards, but the projected noise increase above baseline levels could exceed the 3 dBA threshold of perception.

During closure and post-closure (i.e., after year 20), the major noise sources and activities at the Mine Site and Plant Site (e.g., drilling, blasting, mining, excavation work, hauling, and crushing operations) would cease. Progressive reclamation would occur throughout the 20-year mine life for features such as the permanent stockpile and pit areas at the Mine Site and at the exterior slopes of the Tailings Basin at the Plant Site. This would leave a smaller portion of the Mine Site and Plant Site needing to be reclaimed at closure. During the closure phase, machinery, such as planters, used to restore and/or rehabilitate the Mine Site and Plant Site and conduct other reclamation activities (e.g., structure demolition, dike removal, etc.) would generate some noise; however, such noise would occur over a short time period and mostly during daytime periods when increased noise levels would be more tolerable. Therefore, noise levels at the Mine Site and Plant Site during the closure and post-closure phases are expected to be below the Minnesota noise standards.

5.2.8.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and there would be no increase in noise and vibration levels in any of the areas proposed for project development Therefore, there would be no change in existing noise and vibration levels at the closest receptors.

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5.2.9 Cultural Resources

This section summarizes the environmental consequences of the NorthMet Project Proposed Action on historic properties, including the potential effects, types of avoidance, effect minimization measures, and potential mitigation measures that are relevant to these historic properties. The Co-lead Agencies have identified several historic properties in consultation with the SHPO and the Bands. The Co-lead Agencies have also consulted with the SHPO and the Bands concerning NRHP eligibility of the Sugarbush, *Mesabe Widjiu*, Vermillion to Beaver Bay Trail, Erie Mining Company Railroad Mine and Plant Track, and Erie Mining Company Concentrator Building. All other cultural resources identified as part of the NorthMet Project Proposed Action were determined to be not eligible for inclusion in the (NRHP, and therefore will not be affected by the NorthMet Project Proposed Action. The Co-lead Agencies, the SHPO, and the Bands concur with these eligibility determinations. The Co-lead Agencies are currently refining statements of significance and boundaries for these properties. Preliminary effect determinations have been drafted by the Co-lead Agencies for review and comment by the Bands and the SHPO. The Co-lead Agencies have determined that there will be no effect to the Spring Mine Lake Sugarbush and the Erie Mining Company Railroad Mine and Plant Track. However, the Mesabe Widjiu, Vermillion to Beaver Bay Trail, and Erie Mining Company Concentrator Building will be adversely affected by the NorthMet Project Proposed Action. These preliminary determinations will be used to facilitate ongoing consultation with the Bands and the SHPO pertaining to the application of adverse effect criteria to these properties. Mitigation measures to resolve adverse effects would be developed after consultation on the effect's determinations and consideration of any measures to avoid or minimize adverse effect.

5.2.9.1 Methodology and Evaluation Criteria

In consultation with the SHPO and the Bands, the Co-lead Agencies must apply the criteria of adverse effects to historic properties within the APE to evaluate the potential effect of the NorthMet Project Proposed Action on the historic properties, as codified in 36 CFR 800.5.

An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the NRHP. These criteria for eligibility are discussed at length in Section 4.2.9. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative.

Direct effects are caused by the undertaking and occur at the same time and place. Indirect effects include those caused by the undertaking that are later in time or further removed in distance but are still reasonably foreseeable. Reasonably foreseeable effects caused by the undertaking may occur later in time, be distant, or be cumulative. The Co-lead Agencies confer with consulting parties when there are potential adverse effects, to resolve adverse effects, and develop mitigation measures as necessary. For the NorthMet Project Proposed Action, the following are the main effects that could occur:

- physical disturbance or damage to all or part of the property caused by ground disturbance (e.g., digging, trenching, etc.);
- introduction of visual, atmospheric, or audible elements that could diminish the integrity of the property's significant historic features during short-term NorthMet Project Proposed Action-related construction and operation of aboveground facilities and roads, as well as long-term effects from operation;
- change in the character of the use or of physical features within the property's setting that contribute to its significance; and
- transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's significance.

Effects determinations have the following three possible outcomes:

1. Finding of no historic property affected – The undertaking does not have the potential to cause effects on historic properties that may be present.
2. Finding of no adverse effect – The historic property would be affected; however, the effects of an undertaking do not meet the criteria of adverse effect, or measures have been taken to avoid or minimize adverse effects.
3. Finding of adverse effect – The undertaking may affect the integrity, which would alter, directly or indirectly, any of the characteristics of a historic property that qualify it for inclusion in the NRHP. Such changes could diminish the integrity of the property's location, design, setting, materials, workmanship, feelings, or association. If an adverse effect is found, the Co-lead Agencies shall consult further to resolve the adverse effect.

Historic properties, as defined under Section 106 of the NHPA, would be determined eligible for inclusion in the NRHP by the Co-lead Agencies, in consultation with the Minnesota SHPO and the Bands. The consultation is necessary to discuss eligibility and to implement the avoidance or mitigation of adverse effects on historic properties to the extent practicable. Effects on NRHP-listed or NRHP-eligible cultural resources have been assessed based on how effectively they would be avoided, minimized, or mitigated.

Natural resources important to Ojibwe culture can be recognized even when tribal use of a natural resource may not qualify that resource as a historic property in the NRHP. The right to hunt, fish, and gather on lands within the 1854 Ceded Territory is protected by the 1854 Treaty. Limitation or elimination of access to public lands within the 1854 Ceded Territory for these purposes would be considered an effect on Treaty rights. The loss of traditional use areas would have a cultural effect because commonality of place is essential in Ojibwe culture and the replacement of those sites may not adequately replace their cultural value.

A goal of the 1854 Treaty resources analysis was to determine the most culturally important natural resources to the Bands so that direct and indirect effects could be measured. These resources could also indicate the health of ecosystem categories. Unfortunately, this type of analysis is not possible for people outside of the specific Native American culture. Traditional Native American values and perspectives regarding land and the natural world encompass not only the visible physical aspects, but also spiritual relations with plants and animals. However, this analysis attempts to establish a more encompassing view of large landscapes and connected ecosystems that can then be used to discuss effects.

5.2.9.1.1 Types of Potential Effects

The potential for the NorthMet Project Proposed Action to affect a cultural resource may depend on the project stage and the development and use of the NorthMet Project area. Potential effects that may occur during the construction and operations of the NorthMet Project Proposed Action are discussed in the following subsections.

Construction

NorthMet Project Proposed Action construction activities could affect cultural resources in a variety of ways, including the following:

- possible direct damage to cultural resources within the construction footprint;
- possible indirect damage to cultural resources through vibrations caused by earth-moving and heavy equipment;
- temporary loss of community access to cultural resources, such as cultural resources of traditional significance;
- potential permanent visual effects that alter the viewshed to or from a cultural resource as it pertains to the cultural resource's setting and feeling;
- potential temporary visual effects on cultural resources while heavy equipment and numerous personnel are present;
- increased dust and noise that may affect historic structures or cultural resources of traditional significance near the construction area; and
- discovery of previously unknown cultural resources within the construction footprint.

The duration of the construction phase would affect the degree of effects on cultural resources. Potential indirect effects during construction—such as noise, dust, vibrations, heavy equipment traffic, and changes in viewshed—could be temporary and would be expected to last for the duration of construction in specific areas and for discrete periods of time.

Direct effects, such as the discovery of previously unknown cultural resources during construction, could have a permanent effect on that resource.

Operations

During the operations phase of the NorthMet Project Proposed Action, only previously surveyed and assessed areas would be expected to require periodic disturbance; therefore, the potential for additional direct effects to cultural resources would be limited.

Indirect effects during operations could consist of a permanent change in viewshed to historic structures near NorthMet Project area facilities, and a periodic increase in noise, vibration, and dust created by vehicular traffic conducting operation and maintenance activities.

5.2.9.1.2 Mitigation Measures

Mitigation measures would be taken to avoid or minimize effects on historic properties, to the extent practicable. The following are potential mitigation measures:

- avoidance, which could be accomplished by shifting the footprint away from the resource, limiting activities in the vicinity of the resource, monitoring construction activities near the resource to inform whether additional actions are warranted, or through any combination of these techniques;
- minimization, which would reduce the effects on the resource through avoidance measures as described above, but would not completely eliminate the effects; and
- mitigation, which would offset that effect through some of the following means:
  - protection of a similar resource nearby;
  - detailed documentation of the resource through data recovery (i.e., excavations, in the case of archaeological sites, or Historic American Buildings Survey/Historic American Engineering Record documentation, in the case of historic structures);
  - contributions to the preservation of cultural heritage in the affected community;
  - interpretative exhibits highlighting information gained about cultural resources through the NorthMet Project Proposed Action; or
  - some combination of these strategies.

In the event of an adverse effect determination, the Co-lead Agencies would consult with the SHPO and the Bands to identify ways to mitigate the harmful effects of the undertaking. The ACHP would also be consulted if advised of a serious problem by a consulting party or member of the public. This consultation process would result in the development of a MOA, which identifies the steps the Co-lead Agencies will take to avoid, minimize, or mitigate the adverse effect.

5.2.9.2 NorthMet Project Proposed Action

This section describes the environmental consequences of the NorthMet Project Proposed Action on historic properties within the APE. As outlined in Section 4.2.9, the Co-lead Agencies, the Bands, and the SHPO agree that the Sugarbush, the *Mesabe Widjiu*, and the Vermillion to Beaver Bay Trail are eligible for inclusion in the NRHP. The Co-lead Agencies are currently refining the boundaries and statements of significance for these properties. The refined boundaries and statements of significance will be the subject of ongoing consultation with the Bands and the SHPO. The Co-lead Agencies have also drafted preliminary effects determinations, which will also be subject to further consultation. However, the Co-lead Agencies are the final decision makers on project effects.

5.2.9.2.1 Cultural Resources

The Concentrator Building (SL-HLC-008) is a key property and reflects Erie Mining Company's decades of experimentation in production and engineering design (Zellie 2007). The Co-lead Agencies have determined the Concentrator Building eligible for inclusion in the NRHP under

Criterion A in the areas of industry and engineering, and also under Criterion C in the area of engineering.

Direct effects to this property would consist of interior and exterior refurbishment and use. For example, emission controls on ore grinding equipment would be replaced with components that meet or exceed the particulate emission standard required of new sources at taconite plants. To reduce space heating requirements, the building insulation would be improved. Additionally, the concentrator building would be demolished at mine closure and decommissioning, consistent with Minnesota state mining standards. There will be minor exterior and interior alterations to the other primary plant buildings and structures. The NorthMet Project Proposed Action will include the construction of several new buildings within the APE adjacent to the Concentrator Building, with indirect effects to the property's setting. Based on the above considerations, the Co-lead Agencies believe that the NorthMet Project Proposed Action will adversely affect the Concentrator Building.

The Co-lead Agencies have determined the Erie Mining Company railroad (SL-HLC-015) eligible for inclusion in the NRHP under Criterion A in the areas of Commerce, Industry, and Transportation. Although the majority of the main track of railroad is outside of the NorthMet Project area, the mine track and plant track segments would be directly impacted within the APE.

Direct effects to this property would consist of refurbishment and use. Expected refurbishment, however, is not expected to cause significant direct alterations. However, the Erie Mining Company railroad would be removed at mine closure and decommissioning, consistent with Minnesota state mining standards. There would be no expected indirect effects, as the use of the Plant Site and mining activities would be consistent with the railroad's original use. Based on the above considerations, the Co-lead Agencies believe that the NorthMet Project Proposed Action will adversely affect the Erie Mining Company railroad.

The Co-lead Agencies have determined the Spring Mine Lake Sugarbush eligible for inclusion in the NRHP under Criterion A for its association with important Ojibwe spiritual and cultural practices. It has also determined eligible for the NRHP under Criterion C as a distinguishable entity—a maple stand— that represents a larger entity of traditional cultural importance. Under Criterion D, the site is significant for its potential to answer important questions about possible 19th century and 20th century Ojibwe maple sugaring practices.

Direct effects to this property will not result from the NorthMet Project Proposed Action. The sugarbush is not within the footprint of the Mine Site, the Plant Site, or any other ancillary NorthMet Project area features.

Possible indirect effects may occur as a result of visual effects that may diminish the integrity of the setting, feeling, or associations of the property, or atmospheric effect changes that may affect the maple trees themselves, which are considered to be contributing to the significance of the property.

Based on a visual effects analysis conducted for the NorthMet Project Proposed Action and the site visits conducted in 2010, the Co-lead Agencies believe that the NorthMet Project Proposed Action will not result in a visual intrusion that would diminish the integrity of setting, feeling, or associations. The sugarbush is a number of miles from the Mine Site and sufficiently screened from the Plant Site and the Tailings Basin where those project features are not visible. The Plant Site and Tailings Basin are existing LTVSMC mine features. Their footprint would not be expanded to any significant extent, nor would the addition of material be visible from the sugarbush to a greater extent than current conditions.

The analysis of possible atmospheric effects that was completed for the NorthMet Project Proposed Action indicates that the sugarbush will not be in an area expected to be affected by dust deposition. The sugarbush and its grove of mature maple trees has existed throughout the past 50 years of mining, which included the use of the existing Plant Site and Tailings Basin as well as numerous mineral extraction locations (mine pits) in close proximity to the sugarbush in relationship to the Mine Site.

The sugarbush may be associated with the trail systems, such as the Beaver Bay to Vermillion Trail, that are known to have traversed this area. The portion of that trail corridor in proximity to the sugarbush has been for the most part destroyed by past mining operations. The NorthMet Project Proposed Action would not result in the loss of any additional portions of that corridor, or trails, in proximity to the sugarbush. For further discussion see the effects discussion to the Beaver Bay to Vermillion Trail.

Based on this analysis, the Co-lead Agencies believe that there will be no direct effects resulting from the NorthMet Project Proposed Action nor will there be any changes to the indirect setting, feeling, or associations of the Spring Mine Lake Sugarbush.

The Co-lead Agencies have determined the *Missabe widjiw* eligible for inclusion in the NRHP under Criterion A for its association with important Ojibwe spiritual and cultural practices. The viewshed is also determined eligible for inclusion in the NRHP under Criterion C as a component of a distinguishable entity—M*issabe widjiw*—that represent a larger entity of traditional cultural importance.

Direct effects to the *Missabe widjiw* will occur at the Tailing Basin, which currently abuts a portion of that land form. Expansion of the Tailings Basin will intrude on that of the *Missabe widjiw*. Direct effects to the *Missabe widjiw* at the Mine Site will not occur as the *Missabe widjiw* is not within the footprint of the Mine Site.

Indirect effects to the *Missabe widjiw* would result from the features at the Mine Site location. Although there are existing mine features between the *Missabe widjiw* and the Mine Site location, the NorthMet Project Proposed Action will further diminish the integrity of setting and feeling. The large scale alterations to the landscape resulting from mine pits, stockpiles, material handling facilities, etc. are permanent changes that will further diminish the association of the *Missabe widjiw* with the natural features of the Partridge River headwaters. Although the Mine Site has been disturbed by logging, roads brushed out for mineral exploration, and linear features, such as Dunka Road or the railroad, these disturbances are smaller, more ephemeral, or not as permanent in nature. The effect of the NorthMet Project Proposed Action this area will also remove a portion of the Beaver Bay to Vermillion Trail corridor, further diminishing the *Missabe widjiw*'s association with that historic property.

Although the Co-lead Agencies are not aware of specific locations adjacent to the NorthMet Project area that are used by the Bands, this does not diminish the significance of effects for the portion of the *Missabe widjiw*. Given the nature of Ojibwe spiritual practices, which is a personal connection to the natural elements of the environment, locations of this type are very difficult to identify. The *Missabe widjiw* is a historic property to which the Ojibwe have had a spiritual connection for hundreds of years. The NorthMet Project Proposed Action will likely preclude the use of this area permanently.

Based on the above considerations, the Co-lead Agencies believe that the NorthMet Project Proposed Action will adversely affect the *Missabe widjiw*.

The Co-lead Agencies have determined the Beaver Bay to Vermillion Trail is significant for the role it played in the broad patterns of Ojibwe land use and early mineral exploration. It is eligible for inclusion in the NRHP under Criteria for Evaluation A and D.

The portion of the Beaver Bay to Lake Vermilion Trail corridor that lies within the Mine Site will be directly affected by the NorthMet Project Proposed Action, which will result in its permanent removal. Indirectly, the NorthMet Project Proposed Action would affect the larger trail corridor, which is poorly defined at this time, through the loss of a corridor segment and its association to the larger property and contribution to setting and feeling.

Based on this, the Co-lead Agencies believe that the NorthMet Project Proposed Action will adversely affect the Beaver Bay to Lake Vermilion Trail.

5.2.9.2.2 Treaty Resources

An analysis of effects on 1854 Treaty resources, as described and discussed in Section 4.2.9, is limited by the lack of available information concerning the use of such resources. Determining how the Bands have traditionally conducted their usufructuary rights on or near the NorthMet Project area would only be available through a detailed ethnographic study of individual Band members and their families. The cultural resources investigations included Band member interviews with Bois Forte, Fond du Lac, and Grand Portage, although only Bois Forte's results were made available. The results of the interviews and the cultural resources investigation did not find any natural resources that would be considered a TCP or other traditional cultural place.

There is also no quantitative analysis of current use of Treaty resources in or near the NorthMet Project area. Currently, there is also likely limited subsistence gathering at these sites due inaccessibility. This lack of data also precludes the analysis of how Band members would be quantitatively affected socioeconomically by effects on 1854 Treaty resources, further discussed in Section 5.2.10. The primary source of data for assessing effects on 1854 Treaty resources is from the analysis of the environment in other chapters of this SDEIS as discussed in Section 4.2.9.

As stated in Table 5.2.9-1 below, the NorthMet Project Proposed Action would affect 4,016.1 acres within the Nashwauk Uplands and Laurentian Uplands subsections, which constitutes a total of 0.3 percent of these two subsections.

Table 5.2.9-1 Acres of the Laurentian Uplands and Nashwauk Uplands Subsections Affected by the NorthMet Project Proposed Action

Land Cover	Total Acres	Acres Affected by the NorthMet Project Proposed Action	Percent of Combined Nashwauk Uplands and Laurentian Uplands Subsections Affected by the NorthMet Project Proposed Action
Aquatic Environments	396,966	581.4	0.1
Disturbed	46,174	1,240.9	2.7
Forest	885,566	1,903.6	0.2
Cropland/Grassland	48,602	290.2	0.6
Total	1,377,308	4,016.1	0.3

Source: MDNR 2011g; MDNR 2011i.

The cover type most affected by the NorthMet Project Proposed Action is disturbed land, which includes reuse of the existing LTVSMC Tailings Basin. Less than 1 percent of each of the remaining cover types would be affected. Effects on the 1854 Treaty resources associated with these cover types is discussed below.

Vegetation

Vegetation that would be affected by the NorthMet Project Proposed Action is covered in the vegetation analysis in Section 5.2.4. Consequences of the NorthMet Project Proposed Action would include direct effects on land cover types.

The NorthMet Project Proposed Action would disturb 1,718.6 acres of the Mine Site, with the largest effects to upland conifer forest and lowland conifer forest. Consequently, the plant species or resources regulated by the 1854 Treaty Authority for gathering within these cover types would likely be most affected (Table 5.2.9-2). The Plant Site contains 2,177.5 acres that would be disturbed, although most effects occur in areas already previously disturbed. Though the aquatic environment cover type would be heavily affected at the Plant Site, it consists mostly of tailings ponds where no regulated plant species or resources would be present. The majority of the 120.2 acres of the Transportation and Utility Corridor has also already been disturbed.

Table 5.2.9-2 Affected Cover Types of Associated Species and Resources Regulated by the 1854 Treaty Authority at the NorthMet Project Area

Cover Types	Associated Plant Species or Resource	Affected Mine Site (Acres)[1]	Affected Transportation and Utility Corridor (Acres)[1]	Affected Plant Site (Acres)[1]
Upland coniferous forest	Conifer boughs, princess pine, birch bark, firewood, other plants or forest products	741.9	2.6	52.0
Lowland coniferous forest	Conifer boughs, princess pine, firewood, other plants or forest products	437.2	0.2	20.7
Upland deciduous forest	Princess pine, ginseng, birch bark, firewood, other plants or forest products	354.7	2.7	290.1
Shrubland	Firewood, other plants or forest products	133.0	7.7	139.5
Disturbed	NA	44.0	94.4	1,102.5
Aquatic environments	Wild rice, other plants or forest products	6.0	2.7	572.7
Cropland/Grassland	NA	0.2	9.8	0.0
Upland conifer-deciduous mixed forest	Conifer boughs, princess pine, ginseng, birch bark, firewood, other plants or forest products	1.5	0.0	0.0
Lowland deciduous forest	Princess pine, birch bark, firewood, other plants or forest products	0.0	0.0	0.0
Total	**NA**	**1,718.6**	**120.1**	**2,177.5**

Source: 1854 Treaty Authority 2007.

[1] Acres from Section 5.2.4.

In addition to the direct effects discussed above, there would also likely be indirect effects on cover types. Hydrology changes and dust from traffic and mining operations could affect plant communities near the NorthMet Project area, which could further reduce plant species or resources regulated by 1854 Treaty Authority gathering rights. Mitigation measures, which would minimize these effects, are discussed in Section 5.2.4. Currently, there is also likely limited subsistence gathering at these sites due to them being largely inaccessible.

According to the NorthMet Project Cultural Landscape Study (Zellie 2012), several plant species were identified during surveys. Some of the most common species include balsam fir, speckled alder, and low-bush blueberry (Table 4.2.9-4). These species that were identified in multiple community types are more likely to remain within the NorthMet Project area, despite the direct and indirect effects from the NorthMet Project Proposed Action. Within the combined Laurentian Uplands and Nashwauk Uplands ecological subsections, less than 0.3 percent would be affected by the NorthMet Project Proposed Action. As an estimate, the species or resources listed in Table 4.2.9-4 could likely decrease by the same margin within these ECS subsections.

Wildlife

Similar to the effects on SGCN discussed in Section 5.2.5, the NorthMet Project Proposed Action would affect 1854 Treaty Authority-regulated species as a result of increased human activity and noise, collisions with vehicular and rail traffic, and decrease of habitat. See Section 5.2.5 for a more thorough discussion of the types of effects on wildlife.

Increased Human Activity

The 1854 Treaty Authority-regulated species would be directly affected through increased human activity due to mining activities. Factors such as noise, dust, light, and vehicle traffic may frighten some species and discourage their use of otherwise suitable habitat. Displaced to other habitat, individuals could face increased competition for resources. Less mobile species, such as herptiles (e.g., frogs, turtles), would likely incur relatively high mortality rates due to less ability to leave the affected area. Cliff-nesting birds could be affected by disturbance if they were to nest along the cliffs created by the pit rims.

Noise Effects

Noise associated with mining activities, including noise from vehicle and rail traffic, would likely affect wildlife, including 1854 Treaty Authority-regulated species. Section 5.2.8 provides further discussion on the noise modeling predictions for the NorthMet Project area. Though wildlife species are likely to be sensitive to changes in noise levels, there are no local, national, or international standards or limits that are applicable to the NorthMet Project Proposed Action. Wildlife species may be affected by noise in the NorthMet Project area, though adjacent habitat is available.

Vehicular and Rail Traffic Effects

Traffic effects from collisions with wildlife depend upon factors such as traffic volume, traffic speed, and the species involved. Species that utilize the small preserved forest island remnants between haul roads at the Mine Site would be most affected. Indirect effects from vehicle activities are expected locally at the Mine Site for 1854 Treaty Authority-regulated species and overall local ecosystem. Effects at the Transportation and Utility Corridor are primarily related to vehicle and rail traffic. The 1854 Treaty Authority-regulated species may be affected by noise and light associated with vehicle and rail traffic, and by collisions with vehicles or trains. Transportation effects at the Plant Site are primarily related to vehicle traffic associated with the construction of the Tailings Basin embankments and bentonite application, primarily during the construction phase of the NorthMet Project Proposed Action. The 1854 Treaty Authority-regulated species may be affected by noise and light associated with vehicle traffic and by collisions with vehicles.

Habitat Effects

The direct effect on wildlife habitat, and thus by species regulated by the 1854 Treaty Authority, was assessed by evaluating the acres of habitat types that would be lost under the NorthMet Project Proposed Action. The changes in cover type are summarized in Table 5.2.9-3.

Table 5.2.9-3 Direct Effects on Key Habitat Types

Key Habitat Types	Total Acres[1] of Cover Type Directly Affected at the Mine Site	Total Acres[1] of Cover Type Directly Affected at the Transportation and Utility Corridor	Total Acres[1] of Cover Type Directly Affected at the Plant Site
1. Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	1,535.3	5.5	362.8
2.Open Ground, Bare Soils (no MIH)	44.0	94.4	1,102.5
3.Grassland and Brushland, Early Successional Forest (no MIH)	133.2	17.5	139.5
4. Aquatic Environments (MIH 14)	6.0	2.7	572.7
Total	**1,718.5**	**120.1**	**2,177.5**

Data from Tables 5.2.4-1, 5.2.4-4, and 5.2.4-5.

[1] Total acres may be more or less than presented due to rounding.

Mature Upland/Lowland Forest

At the Mine Site, approximately 1,535 acres of the mature forest would be decreased as a result of the NorthMet Project Proposed Action. All 5.5 acres of mature upland/lowland forest along the Transportation and Utility Corridor would be affected. Approximately 363 acres of 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 (MDNR 2013a).

The 1854 Treaty Authority-regulated species are largely mobile and would likely be displaced, but likely not injured or killed, during mine construction and operation. Reclamation of the Mine Site would include revegetating nearly all disturbed ground according to *Minnesota Rules*, part 6132.2700. Reclamation and revegetation of the NorthMet Project area would improve wildlife habitat relative to conditions during mine operations; however, the quality of habitat for 1854 Treaty Authority-regulated 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

No 1854 Treaty Authority regulated species are identified as utilizing open ground or bare soils habitat at the Mine Site, Transportation and Utility Corridor, or Plant Site. These areas were the result of past mining activity, are generally of low-quality, and are expected to decrease after mine closure as a result of reclamation.

Brush/Grassland

Approximately 133 acres of brush/grassland at the Mine Site would be directly affected by the NorthMet Project Proposed Action. Young trees (less than 4 inches dbh) make up most of this habitat type (ENSR 2005). Though all 17.5 acres of brush/grassland at the Transportation and Utility Corridor would be directly affected, activities at the Transportation and Utility Corridor would not affect grassland/brush 1854 Treaty Authority-regulated species based on the fragmented nature of this habitat. Approximately 140 acres of brush/grassland at the Plant Site would be directly affected by the activities at the Plant Site. The reclaimed Plant Site, specifically the Tailings Basin, would be revegetated with grassland vegetation species. Overall, the NorthMet Project Proposed Action would have no adverse effects on grassland/brush 1854 Treaty Authority-regulated species.

Open Water

The NorthMet Project Proposed Action would create approximately 321 acres of open water at the Mine Site by eventually flooding the West Pit, which is estimated to fill in year 40. At the Plant Site, open water habitat primarily occurs in the existing LTVSMC Tailings Basin. Existing open water habitat would be maintained during operations, though the acreage of open water would fluctuate according to processing needs. See Section 5.2.5 for further discussion of wildlife use of the open water at the NorthMet Project area.

Wetlands

Based on the site-specific wetland delineation, the NorthMet Project Proposed Action would directly affect 775.5 acres of wetlands at the Mine Site, though surrounding similar wetland habitat would likely be adequate to absorb the displaced wildlife. There are 2.7 acres of wetlands/open water (referred to as aquatic environments) along the Transportation and Utility Corridor, all of which would be affected by activities along the corridor. There are 279.9 acres of wetland at the Plant Site and Colby Lake Water Pipeline Corridor (Table 4.2.3-7). On-site wetland use by the 1854 Treaty Authority-regulated species may be limited, and these wetlands are generally considered to be of low quality.

Wetland mitigation is proposed both on and off site. Approximately 385.7 acres of wetland creation is proposed for on-site mitigation. Off-site mitigation would consist of 1,852.6 acres of wetland creation of various habitat types at three sites and an additional 225.0 acres of upland buffer.

Aquatic Species

The potential environmental effects of the NorthMet Project Proposed Action on fish and aquatic macroinvertebrate communities found in the vicinity of the NorthMet Project area are primarily discussed in Section 5.2.6. Direct and indirect effects could include changes in water quality and alteration of physical habitat. Deposition of materials released to the atmosphere, surface runoff of contaminated water, or discharge of contaminated groundwater to the surface water body could potentially alter water quality. Changes in the hydrological regime could also alter the physical habitat in streams due to decreased stream flow.

The NorthMet Project Proposed Action would not result in physical habitat effects on the Partridge River or Embarrass River watersheds as a result of hydrologic changes. Generally, fish species regulated by the 1854 Treaty Authority (Table 4.2.9-6) that occur in the NorthMet Project area would not experience effects from physical habitat loss.

Results of water modeling for the Partridge River Watershed indicate that aluminum and lead would exceed the standards at some evaluation locations. However, since the background levels for aluminum and lead at these locations are essentially identical to the modeled results and already exceed the standard, there would be no added effects from the NorthMet Project Proposed Action. Results of water modeling for the Embarrass River Watershed indicate aluminum would exceed the standard at all evaluation locations and lead would exceed the standard at two evaluation locations. Similarly to the Partridge River, the background levels for aluminum already exceed the standard. In terms of lead, the two potential exceedances would not reflect an actual increase in lead loadings from the NorthMet Project Proposed Action, but rather a reduction in hardness as a result of the proposed groundwater containment system, which would lower the water quality standard for lead because it is hardness-based. Therefore, there would be no added effects from the NorthMet Project Proposed Action. Colby Lake would exceed the evaluation criteria for aluminum, iron, and manganese under the NorthMet Project Proposed Action; however, there would be no added effects due to the high background levels currently in Colby Lake. See Section 5.2.2 for a more thorough discussion of water quality effects and 5.2.6 for a discussion of water quality effects pertaining to aquatic species.

Potential contribution to mercury bioaccumulation can be divided into air emissions and water discharges. Regarding air emissions, contributions of the NorthMet Project Proposed Action from atmospheric deposition could range up to 1.6 percent above current levels in the nearest lakes. The NorthMet Project Proposed Action would be subject to the state-wide TMDL regulations. The potential contribution of the NorthMet Project Proposed Action to mercury bioaccumulation via wastewater, surface water, and groundwater is expected to be below applicable water quality standards, both in nearby waterbodies and downstream in the St. Louis River. See Sections 5.2.2 and 5.2.6 for a more thorough discussion of mercury bioaccumulation.

Overall Effects on 1854 Treaty Resources

As discussed above, the NorthMet Project Proposed Action could have effects on 1854 Treaty resources—i.e., those areas and species that are traditionally or culturally important to the Bands. There are two categories of effects: those relating to the landscape important to Band members, and those relating to plant and animal species of interest to Band members. As discussed above and in other resource-specific sections of the SDEIS, the NorthMet Project Proposed Action would result in direct environmental effects due to ground-disturbing activities. Band members' use of the NorthMet Project area is not well-defined through research at this time, and did not emerge through interviews. A good faith effort was made on the part of the Co-lead Agencies to identify use areas in or adjacent to the NorthMet Project area; however, those efforts resulted in little specific information concerning historic subsistence use and no information regarding recent subsistence activity at the Mine Site, Transportation and Utility Corridor, or Plant Site. In addition, as described in Section 5.2.11, the NorthMet Project area is surrounded by private land, and cannot be easily accessed due to private roads. Thus, there is minimal opportunity for the Bands to exercise usufructuary rights (hunting, fishing, and gathering) on this property.

Construction and operation of the NorthMet Project Proposed Action is not likely to reduce overall availability of 1854 Treaty resources that are typically part of subsistence activities in the 1854 Ceded Territory; however, noise and other consequences of operations could affect migration or other animal species behavior. Additionally, the NorthMet Project Proposed Action could affect the availability of 1854 Treaty resources for some Band members through increased bioaccumulation of mercury in fish, including species associated with subsistence. Effects on the environment, including those from increased mercury, are all expected to meet the standards and regulations set forth by the appropriate state or federal agency or program. These laws are intended to protect important natural and cultural resources and include but are not limited to the ESA, the CWA, and the CAA. Effects on 1854 Treaty resources are difficult to quantify when the effects are within environmental standards yet above current baseline conditions. As such, cultural effects on the Bands would be difficult to quantify in regards to such incremental increases below standards or effects to species where appropriate mitigation is used.

5.2.10 Socioeconomics

This section describes the potential socioeconomic consequences of the NorthMet Project Proposed Action on communities in the study area (consisting of St. Louis, Lake, and Cook counties—see Section 4.2.10 and Figure 4.2.10-1). Socioeconomics includes demographic characteristics of the study area's population, economic characteristics (employment, income, market composition—i.e., the types of firms and employers located in the study area), public finance, housing, public services, and the economic characteristics of subsistence activities. The cultural aspects of subsistence, specifically for Native American populations, are discussed in the Cultural Resources section 5.2.9. Individual subsistence products (e.g., wild rice, game animals, etc.) are discussed in appropriate resource-specific sections of the SDEIS.

Summary

The NorthMet Project Proposed Action would generate as many as 500 direct jobs during peak construction and 360 direct jobs during operation. These direct jobs would generate additional indirect and induced employment, estimated to be 332 additional construction-phase jobs and 631 additional operations-phase jobs. While some skilled workers would be involved only temporarily and possibly relocate from outside the region, the majority of the NorthMet Project Proposed Action-related jobs are expected to be filled by those currently residing in the Arrowhead region.

Federal, state and local taxes would total an estimated $16 million annually. During operations, there would be approximately $231 million per year in direct value added through wages and rents and $332 million per year in direct output related to the value of the extracted minerals. As with employment, these direct economic contributions would create indirect and induced contributions estimated at $99 million in value added and $182 million in output.

The NorthMet Project Proposed Action would create slightly increased demand for housing and public services in cities and towns near the NorthMet Project area. The resulting increase in housing demand and prices could have minor effects on the Environmental Justice populations.

The NorthMet Project No Action Alternative would have no effects.

5.2.10.1 Methodology and Evaluation Criteria

As discussed in Section 4.2.10, the study area for socioeconomics includes Cook, Lake, and St. Louis counties. Because socioeconomic consequences are measured and felt across a broad geographic area, this section does not distinguish between the Mine Site, Transportation and Utility Corridor, and Plant Site. Rather, this section describes the socioeconomic consequences of the NorthMet Project Proposed Action across the entire three-county study area and, where appropriate, includes the study area communities listed in Section 4.2.10.

5.2.10.1.1 Evaluation Criteria

Specific criteria used to evaluate socioeconomic consequences include the following:

- Changes in local population, employment, or earnings associated with NorthMet Project Proposed Action operations.

- Changes in public sector revenues, expenditures, or the underlying fiscal conditions of local governments.
- Changes in economic activity for non-mining industries in the region, particularly the tourism industry.
- Changes in demand for temporary or permanent housing during NorthMet Project Proposed Action 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 discernible reduction in the level of service provided.
- Displacement or other use of property that affects residences or businesses.
- Disproportionate effects on minority (including Native American) or low-income populations, including human health or environmental effects, and subsistence—especially if the NorthMet Project Proposed Action results in large reductions in abundance or major redistribution of subsistence resources, substantial interference with harvestable access to active subsistence sites, or major increases in non-rural resident hunting (Barnard Dunkelberg 2009).

5.2.10.1.2 Determination of Study Area

As discussed in Section 4.2.10, the socioeconomic study area for this section includes all of Cook, Lake, and St. Louis counties (the three counties that comprise the Arrowhead region of Northeastern Minnesota). This study area includes the Mine Site, Transportation and Utility Corridor, and Plant Site, as well as all of the tracts involved in the Land Exchange Proposed Action. The size of this study area also captures much of the region's recreational resources (which are important economic engines) and a substantial portion of the 1854 Ceded Territory. Finally, the three-county study area is large enough to reflect a regional economic picture against which the NorthMet Project Proposed Action's effects can be compared.

Where possible, the analysis of effects is based on a quantitative comparison of baseline conditions (Section 4.2.10) against predicted future conditions in the entire three-county area. In cases where such quantitative data are not available for the entire region (e.g., the IMPLAN model discussed in Section 5.2.10.1.3), the evaluation of effects is either limited to St. Louis County—the site of the NorthMet Project area—or includes the other counties but only qualitatively.

5.2.10.1.3 IMPLAN Model Methodology

Many of the socioeconomic effects of the NorthMet Project such as increased population, housing demand, and effects on public facilities and services are functions of the jobs and revenue that the NorthMet Project Proposed Action creates. To model these effects, the UMD Labovitz BBER used the IMPLAN software package. IMPLAN uses an input-output approach to model the economic effects of changes in baseline conditions (e.g., a large industrial project such as the NorthMet Project Proposed Action). IMPLAN reports direct, indirect, and induced effects in terms of employment, output (the value of production), and value added (wages, rents, taxes, etc.).

For the SDEIS, BBER used version 3.0 of IMPLAN; this version uses economic baseline data from 2009, the most recent year for which data were available (BBER 2012). Due to their small populations, workforces, and their distance from the NorthMet Project area, Cook and Lake counties are not expected to experience substantial additional effects from the NorthMet Project Proposed Action. As a result, the IMPLAN model includes only St. Louis County, which acts as a proxy for the entire three-county study area.

Economic effects were modeled for two construction phases: a 15-month Phase I and a 12-month Phase II that would begin 6 months after completion of Phase I. The phases represent two distinct periods of activity in mine construction involving distinct skill sets and activities. Two operations phases were also modeled: a six-month Startup Phase and a Typical Year (BBER 2012). The IMPLAN model did not include effects during the closure phase or the post-closure period. The IMPLAN model focuses on three categories of economic effects:

- Employment: calculated in terms of jobs, not FTE positions. The model does not make a distinction between full-time, part-time, permanent, or temporary jobs.
- Value added: measures economic contributions to the local economy through wages, rents, interest, and profits.
- Output: the value of the goods or services (e.g., minerals and processed mineral products) produced.

Each category of effects is comprised of three separate components:

- Direct effects: new jobs, spending, and output resulting directly from the NorthMet Project Proposed Action (e.g., PolyMet employees, salaries, spending, and sales).
- Indirect effects: additional inter-industry spending and employment resulting from direct effects (e.g., wholesale purchase of tires by tire retailers who are NorthMet Project Proposed Action vendors).
- Induced effects: additional household expenditure resulting from the direct and indirect effects (e.g., increased patronage of local restaurants by employees of PolyMet or affiliated industries).

The findings of the IMPLAN model are presented in section 5.2.10.2.

5.2.10.1.4 Sources of Uncertainty and Variability

The anticipated socioeconomic effects of the NorthMet Project Proposed Action are based on the best available data, economic modeling, and lessons learned from the history of metal mining in the Mesabi Iron Range. As this history shows, there are numerous sources of economic uncertainty surrounding a project such as the NorthMet Project Proposed Action. The largest overarching socioeconomic concerns related to the NorthMet Project Proposed Action are listed below. Their relationship to the determination of effects is discussed, as appropriate, throughout the remainder of Section 5.2.10.

Industry Cycles

The feasibility of mining is strongly tied to the market price of the commodities being extracted. When prices are high, mining activity is high (the "boom"); when prices drop, mining activity can often slow down or cease entirely (the "bust"). Such changes in mining activity would have effects on host communities. The diverse economy of the study area could offset the degree to which the effects of a bust are experienced. Though this "boom and bust" phenomenon is often present in mining economies, IMPLAN does not model this phenomenon (or assume that it will occur) because the duration of a boom or bust and the severity relative to modeled commodity prices cannot be predicted. Table 5.2.10-1 shows the metal prices assumed in the IMPLAN model, along with recent average prices and the lowest prices experienced during the 2008-9 recession. The potential effects of major changes in commodity prices are addressed in the discussions of effects during the operations phase.

Table 5.2.10-1 Comparison of Assumed (IMPLAN) and Actual Commodity Prices

Commodity	Price Assumed in IMPLAN[1]	Average Actual Price[2]	Recent Low Price[3]
Copper	$2.90/lb	$3.56/lb	$1.39/lb
Nickel	$12.20/lb	$9.47/lb	$4.39/lb
Cobalt	$23.50/lb	$111.69/lb	$13.56/lb
Platinum	$1,230.00/oz	$1,689.00/oz	$843.00/oz
Gold	$635.00/oz	$1,485.00/oz	$755.00/oz

Sources: BBER 2012 (commodity prices); Foth 2012 (average actual price); 2012m (recent low price).

1 Prices based on PolyMet's 2008 Bankable Feasibility Study (PolyMet 2008). This is the most detailed published information available, and PolyMet is legally bound to these data.
2 Three-year rolling average metal prices as of June 30, 2012 (Foth 2012)
3 Monthly low during 2008-2009 recession.

Changes in Industrial Productivity

Throughout the nation, "regional labor productivity [in mining and overall]…has increased dramatically" since publication of the 2009 DEIS (BBER 2012). Over the longer term (since approximately 1980), mining productivity in the Arrowhead region has also increased, due to mechanization and technological innovation (Powers 2007). As a result, far fewer miners are now required per unit of extracted material than before, which therefore lessens the effects of booms and busts in mining communities. Continued technologically driven productivity increases could lead to lower employment than assumed by IMPLAN or other projections.

Local Employment

The NorthMet Project Proposed Action's socioeconomic effects may be influenced by the degree to which PolyMet hires employees who already live in the socioeconomic study area. The SDEIS assumes that at least some (but not all) direct and indirect jobs will be filled by current study area residents; more specific assumptions about the construction, operations, and closure phases are discussed in subsequent portions of this section, as are the ways in which changes in "local" employment shares would affect different aspects of the study area's socioeconomic character.

5.2.10.2 NorthMet Project Proposed Action

This section evaluates the NorthMet Project Proposed Action's effects on socioeconomics in the three-county study area.

5.2.10.2.1 Population and Population Trends

This section discusses the changes in the study area's population resulting from the NorthMet Project Proposed Action. These population changes are driven primarily by project-related changes in employment.

Construction

IMPLAN modeling estimates that construction activities would create an average of 500 direct and 128 indirect construction jobs over the 18-month Phase I period (the most labor-intensive portion of the construction phase). The 204 induced jobs during this phase are likely to be existing residents hired to accommodate the additional demand from direct and indirect jobs.

Typical mine construction involves fluctuating work flows and specialized crews that may be employed for short duration tasks within the construction time frame. Very few construction phase employees would work within the NorthMet Project area for the entire 30-month construction period (including Phase I, the 6-month gap, and Phase II).

Given the NorthMet Project area, most construction employees would likely be from Minnesota, and many would already live in the study area. Many direct and indirect employees are likely to reside outside of the communities in the immediate vicinity of the NorthMet Project area (e.g., Hoyt Lakes, Babbitt, Biwabik, Aurora). However, mine workers in the Arrowhead region and beyond "are willing to commute considerable distance to…well-paid jobs…to protect investment in their homes" (Powers 2007). This finding is generally true of mine construction workers as well. As a result, most employees (regardless of project phase) would not need to relocate.

Due to the proximity of the NorthMet Project area to population centers such as Duluth (80 miles), Hibbing (50 miles), and Virginia (25 miles), the SDEIS assumes that 80 percent of direct and indirect construction labor (approximately 500 employees during Phase I of construction, which requires more workers than Phase II) would commute to the NorthMet Project Proposed Action construction site on a regular basis (PolyMet 20121). The SDEIS assumes that another 5 to 10 percent of direct and indirect workers (approximately 25 to 50 employees) would temporarily reside in the study area, at local hotels or in designated mobile home facilities, but would not relocate their families to the region.

The remaining 10 to 15 percent of the direct and indirect workforce (as many as approximately 100 employees) would relocate to the study area for portions (or all) of the construction process (PolyMet 20121). An influx of 100 workers would equate to as many as 225 total new residents (including family members—see the average population per housing unit in Table 4.2.10-14) who would seek long-term (e.g., more than a few months) residences in nearby communities. This represents an increase of less than one quarter of one percent over the 2010 population of the study area (approximately 216,000 residents—see Table 4.2.10-1), and slightly more than a 2 percent increase in the population of nearby cities (Aurora, Babbitt, Biwabik, Hoyt Lakes, Tower, and Virginia). Such a small increase would not meaningfully change the demographic composition of the study area; thus, construction of the NorthMet Project Proposed Action would have negligible effects on population.

Operations

During typical operations, the NorthMet Project Proposed Action would generate 360 direct and 330 indirect jobs. Direct and indirect employees are likely to work at the NorthMet Project Proposed Action site for a substantial period of time (perhaps as long as the 20-year projected life of the mine), thus permanent employees who do not already live within commuting distance (i.e., in the study area) are likely to relocate to the study area. It is not known how many direct employees will be current study area residents. PolyMet estimates that as many as 338 of the 360 new direct operations-phase positions (94 percent of these positions) could be filled by study area residents (PolyMet 2012k).

For purposes of this analysis, the SDEIS assumes that approximately 75 percent of direct and indirect operations phase employees would be local residents who would not need to relocate as a result of employment. The SDEIS also assumes that the vast majority of the 301 induced jobs created during operations would be filled by existing residents or the spouses and children of new NorthMet Project Proposed Action employees.

The remaining 25 percent of operations-phase workers (approximately 175 employees) would relocate to the study area with their families, causing a total increase of approximately 400 new residents (see the average population per housing unit in Table 4.2.10-14). This is less than one quarter of one percent of the study area population (approximately 216,000 residents).

These workers are likely to be younger, on average, than the existing populations of the study area communities, and may have higher overall incomes. Other demographic characteristics (race, level of education) cannot be determined. The effect of such a shift on housing and public services is discussed below.

Increases in worker productivity spurred by technological change could reduce the anticipated number of direct, indirect, and induced employees. The effect of such reductions would be to reduce the overall new population of the study area. This in turn would diminish the NorthMet Project Proposed Action's demographic effects.

Reclamation and Closure

During the closure of the NorthMet Project Proposed Action, PolyMet estimates that a reduced number of employees and contractors would remain employed for approximately 3 to 4 years for building demolition, but other closure activities would likely be followed by several years of reclamation activities (e.g., surface water quality monitoring). PolyMet is in the process of finalizing reclamation designs and estimates. Current estimates are based on experience at closure of the former LTVSMC processing plant and include 30 to 50 FTEs for the first 7 years, which includes demolition, remediation, reclamation, construction, and monitoring, and 5 to 10 FTEs for the following 30 years, which includes a period of monitoring, reporting, and active water treatment. During closure, direct, indirect, and induced employment associated with the project would decline. All other factors being equal, by the end of the seven-year closure period, the demographic characteristics of the study area would likely revert to levels that could be expected under the NorthMet Project No Action Alternative.

5.2.10.2.2 Employment and Income

Table 5.2.10-2 shows the anticipated economic contributions of the NorthMet Project Proposed Action, as modeled using IMPLAN. The IMPLAN model includes assumptions about the portion of employment, value added, and output that accrues to the study area (in the case of the IMPLAN model, this is limited to St. Louis County), as opposed to the amount that "leaks" to locations outside of St. Louis County (BBER 2012). While the data in Table 5.2.10-2 depict the economic effects of the project specifically on St. Louis County alone, they capture the vast majority of the NorthMet Project Proposed Action's effects in the entire three-county study area. By comparison, Minnesota's forecasted operating budget for 2012 and 2013 is $62.4 billion (State of Minnesota 2012).

Table 5.2.10-2 Summary of IMPLAN Model Results

Phase[1]	Direct Effect	Indirect Effect	Induced Effect	Total
Construction Phase I				
Value Added[2]	$143,637,243	$41,774,260	$61,120,854	**$246,532,357**
Output[3]	$312,000,009	$75,343,964	$101,199,927	**$488,543,900**
Employment	500	128	204	**832**
Construction Phase II				
Value Added	$75,501,628	$21,958,266	$32,127,628	**$129,587,122**
Output	$164,000,005	$39,603,897	$53,194,833	**$256,798,717**
Employment	264	68	107	**439**
Operations Phase – Startup				
Value Added	$44,619,571	$12,117,664	$6,865,833	**$63,603,068**
Output	$64,122,003	$23,821,174	$11,367,855	**$99,311,032**
Employment	300	275	251	**826**
Operations Phase – Typical Year				
Value Added	$231,315,193	$62,819,962	$35,593,610	**$329,728,765**
Output	$332,418,993	$123,492,880	$58,932,833	**$514,844,706**
Employment	360	330	301	**991**

Source: BBER 2012.

1 The IMPLAN model did not include effects during the closure phase or post-closure period.
2 Defined in BBER 2012 as "a measure of the affecting industry's contribution to the local community; it includes wages, rents, interest and profits."
3 Defined in BBER 2012 as "the value of local production required to sustain activities."

Construction

Construction of the NorthMet Project would create as many as 832 jobs during the peak of Phase I, of which 500 would be mine construction jobs. Indirect and induced employment would be spread across a variety of industries, such as engineering, restaurants, medical providers, and hospitals (see Table 10 in BBER 2012). The NorthMet Project Proposed Action-related construction employment would increase overall study area employment by less than one percent at its peak (less during Phase II).

As discussed in Section 5.2.10.2.1, the SDEIS assumes that a substantial share of direct construction jobs will be filled by study area residents—particularly those with construction experience—while other study area residents will obtain indirect and induced jobs. Construction is therefore expected to at least marginally reduce the unemployment rate in the study area.

The IMPLAN model does not specify how much of the estimated $376 million in total value added during the two parts of the construction phase would be dedicated to employee salaries, although employee pay is assumed to be a substantial share. The value added (and thus earnings) from the NorthMet Project Proposed Action are likely to be substantial compared to other non-ferrous (e.g., copper, nickel, lead, zinc) mining activity, but will be limited to the construction phase. A study of mining in northeastern Minnesota estimated that non-ferrous mining contributed approximately $250 million in value added statewide in 2007—the vast majority of which is from the Arrowhead region (BBER 2009).

While employment related to construction of the NorthMet Project will have minimal effects, the earnings from construction employees would be positive, albeit relatively short-lived (e.g., for no more than the 36-month overall construction phase).

Operations

Overall Effects

During typical year operations, the NorthMet Project Proposed Action would generate nearly 1,000 total direct, indirect, and induced jobs. This would increase study area employment by approximately one percent. One-third of new employment (360 jobs) would be direct mine-related jobs. The remainder would be spread among a variety of industries, such computer programming, restaurants, engineering, and health care (BBER 2012).

As discussed in Section 5.2.10.2.1, the SDEIS assumes that a substantial share of direct operations jobs will be filled by study area residents, particularly those with mining experience. In 2009, there were approximately 3,000 mining jobs in the study area (U.S. Census Bureau 2009). This figure does not include residents who have skills appropriate for the mining sector but who are not currently employed in mining. Other local residents are likely to obtain indirect and induced jobs. Operation of the NorthMet Project Proposed Action could reduce unemployment in the study area by nearly one percent (991 new jobs out of 111,090 members of the workforce, see Table 4.2.10-9).

The IMPLAN model does not specify how much of the estimated $330 million in total value added during typical operations would be dedicated to employee salaries, although employee pay is assumed to be a substantial share. The NorthMet Project Proposed Action's estimated value added (and thus earnings) is substantial compared to the 2007 estimate of $250 million in annual statewide value added economic effects from non-ferrous mining (BBER 2009).

Earnings and all economic contributions of the NorthMet Project are influenced by external market factors, such as those discussed in Section 5.2.10.1.4. Significant decreases in metal prices and/or competition from other regions or countries can lead to reduced production. PolyMet states that, due to its structure as a "low-cost producer," the NorthMet Project Proposed Action would be unlikely to completely cease operations during a recession (PolyMet 2012m). That statement notwithstanding, complete suspension of mining activity is not an uncommon response to recession or significant drops in commodity prices. This "bust" aspect of the cyclical economy is familiar to mining regions in Minnesota and beyond (Powers 2007; Freudenberg and Wilson 2002). Increases in productivity may not affect the output of the NorthMet Project Proposed Action (i.e., the sales price of the extracted and processed materials), but could reduce employment and value added.

To account for some of these concerns, commodity prices in the IMPLAN model are generally conservative, compared to price trends. In particular, copper, gold, and platinum prices used in the IMPLAN model are significantly below recent average prices. Nickel and cobalt, which are expected to comprise a small share of the total volume extracted by PolyMet, are significantly above current average prices, but were also conservative compared to contemporary prices that formed the basis of PolyMet's 2008 Bankable Feasibility Study (see notes in Table 5.2.10-1). Section 5.2.10.1.4 provides more information about sources of uncertainty and variability.

The IMPLAN estimate of 1,000 new jobs and $330 million in annual value is likely a cautiously optimistic estimate (although not a "best-case scenario," which would assume much higher commodity prices). A less productive NorthMet Project Proposed Action—for example, if the NorthMet Project would only contribute half of the jobs and value added predicted by IMPLAN—would still represent a substantial contribution to the study area and state economy. The contribution to value added would be more substantial than to employment.

Effects on Regional Tourism

Tourism is rooted in the Arrowhead region's unique recreation opportunities such as BWCAW, and is more broadly dependent on recreational opportunities such as hunting, fishing, boating, sightseeing, and wilderness experiences provided by the region's high-quality natural environment.

Mining and tourism have coexisted in the study area for decades. As shown in Table 4.2.10-7, industries associated with tourism (arts, entertainment, recreation, accommodation, and food) account for nearly 13 percent of all employment in St. Louis County (data could not be summed for the entire study area). The "attractive landscape and climatic features [of the region have] attracted recreationists, retirees, and other new residents" (Powers 2007). In particular, retirement income (from individuals who move to the Arrowhead region for its recreational and scenic resources) has been an important source of economic vitality for the region's communities (Powers 2007). These non-mining economic gains have occurred in the presence of active mining activity (including the Northshore Mine adjacent to the NorthMet Project area) and the remnant landscape of past mining activity.

Effects on species (game animals, fish, and vegetation) and resources (water quality, air quality, and noise) that contribute to the tourism industry are discussed in appropriate sections of Chapter 5. Housing is also an important component of the tourism industry—the Arrowhead region is often regarded as a location for long vacations, rather than short day-trips—and is discussed in Section 5.2.10.2.4. To the degree that the NorthMet Project Proposed Action adversely affects those resources, then it also has the potential to affect the tourism industry. However, the presence of the NorthMet Project Proposed Action would not significantly affect regional recreation or visual resources (see Section 5.2.11.2.1), and there is also insufficient evidence to suggest that the presence of the NorthMet Project Proposed Action would affect the tourism industry as a whole.

Reclamation and Closure

As discussed in 5.2.10.2.1, the NorthMet Project Proposed Action would retain a small workforce, generating a corresponding small number of indirect and induced jobs, to perform post-mining activities such as demolition and reclamation as well as to maintain a very small post-closure staff. Using the IMPLAN model's construction-phase employment multipliers (BBER 2012) a 50-person closure staff (direct employment) could equate to as many as 30 indirect and induced jobs (a decline, compared to the 1,000 operations-phase jobs generated by the NorthMet Project Proposed Action). Because no minerals or other commodities would be extracted, the value added from the closure phase would be limited to employee salaries, rents, and other contributions.

Overall, the employment, output, and value added from the closure phase would be small compared to the study area's overall economy. More important, at mine closure, workers who held operations-phase direct, indirect, and induced jobs would be expected to secure alternative local employment, retire, or relocate out of area. There would likely be a spike in unemployment and a resulting decline in income during the transition between the operations and closure phases. The 991 operations-phase jobs (including direct, indirect, and induced jobs) collectively account for less than one percent of the overall study area workforce (111,090 individuals—see Table 4.2.10-9). Any increase in study area unemployment during and after closure—resulting from individuals who remain in the study area workforce but who cannot find jobs—would be minimal. As former employees move, find new work in the area, or retire, unemployment and income will normalize to levels predicted for the NorthMet Project No Action Alternative (holding all other economic variables constant).

5.2.10.2.3 Public Finance

The IMPLAN model estimates the value of several federal and state taxes, including personal income taxes (i.e., taxes paid by employees on their salaries), indirect business taxes, and other taxes paid as a result of the NorthMet Project Proposed Action for the duration of the project (BBER 2012). The remainder of this section discusses those tax estimates.

Construction

Construction of the NorthMet Project Proposed Action would generate approximately $51 million in federal tax revenue, and $24 million in state tax revenue (combined, both construction phases) (BBER 2012). A portion of these tax contributions would be returned to the study area through various federal programs (e.g., grants to school systems and state governments) and through distributions from the state's general fund. However, such effects on local public finances are indirect and difficult to quantify. Other construction-phase revenues could include sales and use tax on some materials used for NorthMet Project Proposed Action construction, although most such materials and supplies are exempt from the tax (MDR 2011).

Operations

The majority of economic benefits to the local community through taxes would be realized during the operations period. IMPLAN modeling estimates that, during a typical year of operation, the federal government would receive approximately $30 million, and the state and local governments would receive approximately $39 million in taxes from the operation of the NorthMet Project Proposed Action.

PolyMet estimates that, if the NorthMet Project Proposed Action was currently in operation, its direct federal and state tax payments would be approximately $37 to $80 million over a five-year period (PolyMet, personal communication, March 29, 2012.). This equates to approximately $8 to $16 million per year. Table 5.2.10-3 details how these direct tax payments would be divided among different state and federal taxes (as described in Section 4.2.10.1.3), if the NorthMet Project Proposed Action would have been in full operation in 2011. A substantial portion of state taxes would be returned to study area school systems, local governments, and local general funds.

Table 5.2.10-3 Estimated Annual NorthMet Project Proposed Action Taxes Paid, 2011 Dollars (millions)

	Minnesota Taxes[1]	**Federal Taxes[1]**
Net Proceeds Tax	$1.18	NA
Occupation Tax	$1.42	NA
Sales and Use Tax	$0.48	NA
Withholding Tax on Royalty Payments[2]	Undetermined	Undetermined
Ad Valorem Tax	$0.04	NA
Total	**$3.12**	**$12.8**

Source: PolyMet, pers. comm., March 29, 2012.

1 Assumes-full operation in 2011.
2 Royalty payments will be subject to a 6.25% withholding tax. The value of this tax cannot be calculated or estimated at this time.

The magnitude of tax contributions is strongly linked to commodity prices. A significant drop in commodity prices would likely result in a significant reduction in tax revenue generated by the NorthMet Project Proposed Action. Even under such circumstances, operation of the NorthMet Project Proposed Action would benefit the local economy.

Reclamation and Closure

Closure activities would last approximately 20 years after cessation of operations. The first seven years of this period would be the most active, and would include reclamation, demolition, and restoration of the site. Years 7-20 of closure would include low-intensity monitoring, maintenance, and water treatment activities, followed by covering of the Tailings Basin at the end of this period. Low-intensity post-closure activities (such as long-term monitoring and maintenance) would extend indefinitely beyond Year 20 of closure.

During closure and post-closure, the NorthMet Project Proposed Action would generate a small amount of tax revenue from the above activities, primarily from income taxes and business taxes. Other revenue sources, such as net proceeds taxes, and local ad valorem taxes would no longer apply. By the end of the closure phase, contributions to public finances would return to levels that would be expected for the NorthMet Project No Action Alternative. Relative to existing conditions, closure of the NorthMet Project Proposed Action would generate a negligible benefit for public finances in the study area.

5.2.10.2.4 Housing

Housing effects are tied to both employment and earnings; increases in both of these factors can cause increased demand for housing. There are more than 24,000 vacant housing units in the study area, of which approximately 7,000 are “permanent” (not seasonal) vacant units (see Table 4.2.10-14). Of that total, approximately 4,000 non-seasonal vacant units are located in the individual study area communities listed in Section 4.2.10 (the remainder are scattered throughout St. Louis, Lake, and Cook counties). All of these communities are within a reasonable commuting distance of the NorthMet Project area (Powers 2007).

Construction

As described in Section 5.2.10.2.1, 75 percent of the construction-phase employees are expected to commute to their jobs from existing residences in or near the study area. Relatively few construction-phase employees (approximately 100) are expected to permanently relocate to the study area, due to the short-term and transient nature of mine construction. Given the existing vacant housing stock (and including seasonal units, which could be converted to permanent units at the owners’ discretion), this added demand in permanent housing in the study area would be largely imperceptible.

Approximately 25-50 employees may choose to procure temporary housing. This could consist of short-term rentals of available housing units (seasonal or otherwise), and use of mobile home parks or hotels/motels. Lodging and mobile home facilities close to the NorthMet Project area, such as those in Aurora, Hoyt Lakes and Babbitt, could be more heavily occupied throughout both phases of the construction period, affecting both availability and pricing for the region’s tourist demand. However, there are approximately 5,400 hotel rooms and more than 1,400 mobile home berths (as well as park facilities that permit mobile homes) in the study area (Northland Connection 2012). Construction-phase demand for these accommodations would not substantially limit availability.

Operations

Demand for permanent housing is likely to increase during the operations phase. As discussed in Section 5.2.10.2.1, approximately 175 workers would choose to relocate to the study area. The actual number of housing units required to accommodate this demand may be lower (less than 380), due to the presence of two-worker in-migrating households (e.g., the spouse of a direct employee may obtain an indirect or induced job). Even if there are no multiple-worker in-migrating households (an unlikely scenario), the study area has approximately 7,000 vacant non-seasonal housing units. Thus, the study area has adequate housing to accommodate the influx of workers associated with the NorthMet Project Proposed Action.

Individual communities close to the NorthMet Project area may experience more competition for available housing units. While it is unlikely that any single community would achieve 100 percent non-seasonal occupancy, such competition could drive up housing prices and could also encourage the renovation of existing housing units and/or construction of new housing units (either on vacant land or as replacements of older housing units). Given the small number of new residents, such effects would be minor.

As with other economic effects of the NorthMet Project Proposed Action, effects on housing are tied to market fluctuations and workforce productivity. Major changes in levels of production (caused by major changes in commodity prices) could cause effects on housing demand and value. However, the total estimated new housing demand associated with the NorthMet Project Proposed Action is relatively small compared to the region's existing housing supply. Even a market "bust" (a drop in commodity prices so severe that it causes shutdown of the NorthMet Project Proposed Action) should not dramatically alter the housing market in any single community, let alone the study area as a whole.

There are concerns that the presence of the NorthMet Project Proposed Action could reduce housing demand (and thus housing value) in the study area, because of the conflict between the NorthMet Project Proposed Action's heavy industrial character and the high-quality natural environment that supports the region's tourism economy and thus the housing market. As described in Section 5.2.11, the NorthMet Project Proposed Action's effects on recreation and visual resources would be very limited.

Given the coexistence of mining and tourism in the Arrowhead region, the NorthMet Project Proposed Action's effects on the study area's housing values would be minimal. The most likely result of the operation of the NorthMet Project Proposed Action is a minor increase in housing demand and prices in study area communities, with moderate effects in individual communities closest to the NorthMet Project area. Increased housing prices may or may not be a negative effect; average housing values in the communities closest to the NorthMet Project area are relatively low compared to other study area communities. Minor to moderate increases in housing value would likely be seen as a benefit by homeowners, and the opportunity to add newer housing stock (either through rehabilitation of existing units or the construction of new units) to the study area would generally improve property values, thus improving local property tax revenues in those communities.

Reclamation and Closure

During and following reclamation and closure of the NorthMet Project Proposed Action, it is likely that the demand for housing would drop as workers migrate from the area. Housing characteristics (vacancy rates and values) would likely revert to levels that would be expected for the NorthMet Project No Action Alternative. However, increases in housing demand spurred by the strength of the tourism industry and the increasing popularity of the study area for retirement could obscure any such declines.

5.2.10.2.5 Public Services and Facilities

The NorthMet Project Proposed Action would affect public services and facilities in the study area both directly and indirectly. Direct effects would include services provided to the NorthMet Project Proposed Action itself, and would largely be limited to demand for emergency response in the case of an accident. Indirect effects would include increased demand for public services such as potable water, sewer, emergency services, and schools in communities where direct, indirect, and induced employees and their families live.

Most public water and sewer infrastructure in the study area was designed to accommodate larger populations than currently exist; therefore, the NorthMet Project Proposed Action will generally have no effect on these services (see Table 4.2.10-15). As Section 4.2.10.1.5 shows, emergency and medical services are equipped to handle existing demand, and most have mutual aid agreements in place with nearby cities to cooperatively respond to major emergencies.

The public schools in the study area were constructed to accommodate larger populations than currently exist in the study area (e.g., the larger populations that were associated with the iron and taconite mining industry in the 1960s and 1970s). Collectively, public schools in the study area have capacity for nearly 22,000 students, with existing enrollment of nearly 16,000 students. Thus, these schools are able to support new students without building new facilities. To address concerns about maintenance of older buildings, several school facilities in the region have already established renovation programs, and some schools in Duluth plan to downsize (see Section 4.2.10.1.5). These plans predate the NorthMet Project Proposed Action, and would not be accelerated or changed by new population associated with any phase of the NorthMet Project Proposed Action.

The five technical and community colleges and two four-year colleges located throughout the study area provide a variety of degree programs. These schools would continue to provide educational opportunities to new and existing study area residents seeking further education, including high school graduates and existing employees seeking to enhance their job skills. Several community colleges and universities in the study area offer, or are developing, educational curriculum related to jobs in the mining industry.

Construction

Direct demands from construction of the NorthMet Project Proposed Action will primarily fall on local emergency service providers who would respond to any emergencies at the NorthMet Project Proposed Action site.

A small number of construction-phase employees and their families (approximately 225 total new residents, as described in Section 5.2.10.2.1) are expected to permanently relocate to the study area, while another 150 employees would stay in the study area for moderate periods of time (from several weeks to several months), in hotels or mobile homes. All of these employees would generate indirect demand for drinking water, wastewater capacity, and emergency services; the relocated residents would also generate demand for space in public schools.

Public schools in the study area generally have sufficient capacity to accommodate new students. As described in Section 4.2.10.1.5, several school facilities in the region are in need of renovation. This need predates the NorthMet Project Proposed Action, and would not be exacerbated by the relatively small number of new students added by NorthMet Project Proposed Action construction.

Operations

Direct demands from operation of the NorthMet Project Proposed Action will primarily fall on local emergency service providers who would respond to any emergencies within the NorthMet Project area. Approximately 400 operation-phase employees and family members are expected to relocate to the study area (see Section 5.2.10.2.1). All of these employees and their families would generate demand for drinking water, wastewater capacity, emergency services, and school capacity.

Additional police, fire, and ambulance staff may be required to service increased populations in study area cities, particularly in smaller cities. However, these expansions are likely to consist of one to two employees per service (e.g., one new police officer, two new firefighters), per city, as well as upgrades of existing equipment, rather than wholesale expansions of police and fire departments. Increased tax revenues from the NorthMet Project Proposed Action would be expected to cover the costs of these expansions.

Reclamation and Closure

During reclamation and closure of the NorthMet Project Proposed Action, direct and indirect demands for public service would decrease to baseline levels due to the anticipated decrease in population and activity at the Mine Site and Plant Site. Any upgrades to public services and facilities constructed to accommodate operations-phase demands, such as newer police and fire vehicles, would be available to the remaining residents of the study area during closure and post-closure activities.

5.2.10.2.6 Environmental Justice and Subsistence

Evaluation of EJ effects—the degree to which the potential effects of the NorthMet Project Proposed Action or any alternative are felt disproportionately across a community, considering ethnicity, age, gender, income and other demographic characteristics—follow criteria set forth in the following federal EOs:

- EO 12898, (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* 1994), directs federal agencies to incorporate environmental justice into their mission and activities. Federal agencies are to accomplish this by conducting programs, policies, and activities that substantially affect human health or the environment in a manner that does not exclude communities from participation in, deny communities the benefits of, or subject communities to discrimination under such actions, because of their race, color, or national origin.
- EO 13045, (*Protection of Children from Environmental Health Risks and Safety Risks,* 1997), requires each federal agency to identify and assess environmental health and safety risks to children.

In particular, this EJ analysis focuses on the degree to which the NorthMet Project Proposed Action could disproportionately affect the populations described above and includes residents of the study area, as well as Band members who use the study area for subsistence, regardless of where they live.

Minority (non-white) populations comprise less than five percent of the study area, and less than five percent of the individual communities listed in Table 4.2.10-3 (except for the three reservations). By comparison, the minority population of Minnesota was approximately 15 percent. The following groups in the study area meet the criteria described above:

- Approximately 13.5 percent of the study area population is below the federal poverty level, compared to 10 percent for the state.
- Native Americans comprise 2.3 percent of the study area, compared to 1.1 percent of the state population.
- Children (individuals under 18 years of age) comprise nearly 29 percent of the study area population, compared to 24 percent for the state.

Native American tribes exercise usufructuary rights to hunt, fish, and gather plants within the 1854 Ceded Territory, which includes the study area. This section discusses the degree to which the NorthMet Project Proposed Action would disproportionately affect these subsistence practices, with the understanding that these practices have both socioeconomic and cultural value for the Native American tribes. Section 5.2.9 discusses the cultural aspects of subsistence in greater detail.

Construction

As described in Section 5.2.10.2.2, the economic effects of construction of the NorthMet Project Proposed Action would be largely positive. Construction would provide new jobs, substantial new earnings, and indirect contributions to public finances. Potential negative socioeconomic effects of construction of the NorthMet Project Proposed Action include increased demand for short-term housing (hotels and mobile home facilities)—although this is a benefit for the owners of those facilities—and increased demand for public services (especially emergency services). These negative effects are generally minor in severity.

Increased public service demands would not disproportionately affect EJ populations. Increased prices would negatively affect the study area's poorest residents who did not receive a commensurate direct or indirect economic benefit from the NorthMet Project Proposed Action. Approximately 150 workers are expected to relocate to or occupy short-term housing in the study area during construction. This number of new and temporary residents, and therefore demand for public services, is small compared to available vacant housing, although poor residents closer to the NorthMet Project area may experience higher prices and demand than in the study area as a whole.

The NorthMet Project area is within the 1854 Ceded Territory. Section 4.2.10.1.6 summarizes available information about subsistence patterns within the 1854 Ceded Territory; however, there is no information available regarding recent or historic subsistence activity at the Mine Site, Transportation and Utility Corridor, or Plant Site. In addition, as described in Section 5.2.11, the NorthMet Project area is surrounded by private land, and thus cannot be easily accessed. Thus, there is minimal opportunity for the Bands to exercise usufructuary rights (hunting, fishing, and gathering) on this property.

The degree to which construction of the NorthMet Project Proposed Action would affect individual subsistence resources (i.e., fish, game, and plant species) outside of the Mine Site, Transportation and Utility Corridor, and Plant Site is discussed in Section 5.2.9 (Cultural Resources). Construction of the NorthMet Project Proposed Action would not reduce overall availability of fish, game, or plant species that are typically part of subsistence activities in the 1854 Ceded Territory.

Operations

As described in Section 5.2.10.2.2, the economic effects of operation of the NorthMet Project Proposed Action would be largely positive. Operations would provide new jobs, substantial new earnings, and substantial direct and indirect contributions to public finances. In addition, the Bands operate four casinos in or near the study area (the Fond-du-Luth Casino in Duluth, operated by the Fond du Lac Band; the Black Bear Casino in Carlton, operated by the Fond du Lac Band; the Fortune Bay Resort Casino in Tower, operated by the Bois Forte Band; and the Grand Portage Lodge and Casino in Grand Portage, operated by the Grand Portage Band). While the Black Bear Casino is outside of the study area, it is nonetheless close enough to study area communities to potentially benefit from increased visitation and spending. Increased employment and income associated with the NorthMet Project Proposed Action could increase visitation and revenues at these facilities.

Potential negative socioeconomic effects of operation of the NorthMet Project Proposed Action include increased demand for housing (which could negatively affect the study area's poorest residents who did not receive a direct or indirect commensurate economic benefit from the NorthMet Project Proposed Action) and increased demand for public services and facilities.

Increased public service demands would not disproportionately affect minority and low income populations. The influx of direct, indirect, and induced NorthMet Project Proposed Action employees could cause demand for as many as 175 housing units across the study area. While this number is small compared to available vacant housing in the study area, some marginal increase in housing demand and cost, as well as demand for public services, is possible, particularly in communities closer to the NorthMet Project area. Increased housing competition would likely affect the study area's poorest residents, particularly renters (whose housing costs are more volatile), and particularly those living closer to the NorthMet Project area.

As described in the construction phase discussion, there is no evidence of subsistence activity within the federal lands, and the federal lands are not readily accessible. Operation of the NorthMet Project Proposed Action would not reduce overall availability of game or plant species that are typically part of subsistence activities in the 1854 Ceded Territory, although noise and other consequences of operations could affect migration or other animal species behavior—see Section 5.2.5 (Wildlife). Operations could affect fish consumption. In particular, air deposition of mercury from the NorthMet Project Proposed Action could increase mercury concentrations in nearby water bodies by at most 0.3 to 1.8 percent over current levels (Barr 2012b). This increased deposition could lead to increased bioaccumulation of mercury in fish, including species associated with subsistence.

Reclamation and Closure

During reclamation and closure, socioeconomic characteristics of the study area would revert to conditions that would be expected for the NorthMet Project No Action Alternative. Employment, earnings, and contributions to public finances generated by the NorthMet Project Proposed Action would end (potentially with a phase-out period); housing demand and prices would ease as would demands for public services and facilities. Poorer residents of the study area would have more difficulty coping with this transition if they hold lower-paying, less secure "induced" jobs (as opposed to direct or indirect jobs), as they may have more difficulty moving out of the study area to secure new jobs (particularly if housing values drop). However, given the relatively small number of jobs generated by the NorthMet Project Proposed Action (compared to the total number of jobs held by study area residents), these difficulties would not be substantially higher than existing conditions.

As during other phases, the NorthMet Project area would remain closed to the public during and following the closure phase, thus preventing subsistence activities. Since there is no evidence that such activities take place today, closure would represent no change from the current situation. Air deposition of mercury from the NorthMet Project Proposed Action would cease at closure, but mercury bioaccumulation and resultant fish consumption limits would likely persist beyond the mine's operational life.

5.2.10.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. There would be no NorthMet Project Proposed Action-related change to the study area. Externally existing demographic trends such as population growth or decline, and shifts in employment patterns would continue. The study area would not accrue the economic benefits of the NorthMet Project Proposed Action, nor would it experience any of the negative effects identified in this SDEIS. As described in Section 5.2.10.2, the presence of the NorthMet Project Proposed Action would not necessarily hamper growth of the Arrowhead region's tourism industry; the NorthMet Project No Action Alternative would not necessarily hasten this growth, either. Overall, the NorthMet Project No Action Alternative would have no effect on socioeconomics in the study area.

5.2.11 Recreation and Visual Resources

This section describes the potential environmental effects of the NorthMet Project Proposed Action on recreational facilities and activities that typically take place in the NorthMet Project area, as well as the surrounding Arrowhead region. Recreation in this region is strongly tied to the aesthetic condition of the landscape so this section also describes the effects of anticipated project activities on visual resources in the NorthMet Project area and surrounding land.

Summary

Most of the Mine Site, a part of the Superior National Forest, is currently public land. However, the Mine Site is surrounded by private land that lacks public roads or trails and is therefore not publicly accessible. The Transportation and Utility Corridor and Plant Site are privately owned lands and are not open to the public for recreation. Direct effects on recreation in this area from the NorthMet Project Proposed Action will be limited. With the exception of the Skibo Vista Scenic Outlook, views of project activities will be limited by topography and distance. The NorthMet Project could reduce recreational use of nearby lands, including portions of the Superior National Forest, but would not affect recreational patterns and facilities in the Arrowhead region as a whole. The BWCAW and Voyageurs National Park are each more than 30 miles from the NorthMet Project Area. An analysis of potential air quality effects demonstrated that there are no expected effects on visibility in these areas when compared to pristine conditions.

5.2.11.1 Methodology and Evaluation Criteria

5.2.11.1.1 Recreation

The primary issues related to recreational facilities and activities on and near the proposed project facilities include the following:

- direct effects due to construction, operation, and closure of the NorthMet Project Proposed Action resulting in the reduction of the number and/or acreage of recreational facilities (parks, lakes, trails, etc.) potentially available for public use;
- indirect effects of the NorthMet Project Proposed Action, including reduction in the use of recreational facilities in areas surrounding the proposed project facilities due to noise, dust, and other disturbances; and
- the net effect of local (i.e., the area surrounding the Mine Site and Plant Site) and regional recreation during post closure.

Evaluation of the NorthMet Project Proposed Action against these criteria was based on comparison to the USFS ROS for land that is controlled by USFS. The USFS uses the ROS to inventory recreational settings and characteristics (see Section 4.2.11.1 for further explanation of the ROS).

Effects on the region's overall recreation resources (e.g., lands not necessarily controlled by USFS) are based on qualitative analysis of NorthMet Project Proposed Action activities, as they relate to the region's recreational opportunities (as summarized in Section 4.2.11). Specific considerations include distance (both direct and via road or trail) between the NorthMet Project and various recreation resources, and the likelihood that the NorthMet Project Proposed Action would change the noise or visual environment, or the character of water, flora, and fauna present in these resources. These evaluations are based on extensive touring of the region and review of available mapping and descriptive material about the region's recreation resources.

5.2.11.1.2 Visual Resources

The primary issues related to visual resources on and near the Mine Site and Plant Site include the following:

- the nature and severity of effects of the NorthMet Project Proposed Action on sensitive viewpoints, including nearby homes, businesses, and vistas;
- changes to the extent or scale of visible mining disturbances; and
- the ultimate appearance of the NorthMet Project Proposed Action after reclamation is completed versus current and interim stages of active mining.

Evaluation of the NorthMet Project Proposed Action against these criteria was based on comparison to the USFS Scenery Management System classes for land that is or would be controlled by the USFS. The USFS uses the Scenery Management System to identify desired visual conditions, as expressed by SIOs (see Section 4.2.11.1 for further explanation of SIOs).

Effects on the region's overall visual environment (e.g., lands not necessarily controlled by USFS) are based on qualitative analysis of the NorthMet Project's activities (particularly structures, stockpiles, and other visible activities), as they relate to what observers are likely to see in the region. This understanding is based on extensive touring and photo-documentation of views and visual conditions in the region. In addition, GIS, printed maps, and aerial photography were used to identify potential sensitive viewpoints, for which visual simulations of future mine facilities were developed.

5.2.11.2 NorthMet Project Proposed Action

5.2.11.2.1 Recreation

Surface rights to most of the Mine Site are held by the USFS, as part of the Superior National Forest. As described in Section 4.2.11, the ROS classes for the portion of the Mine Site located on federal lands are Semi-Primitive Motorized and Roaded Natural. The setting and characteristics of the portion of the Mine Site located on private lands is similar to the Roaded Natural class. However, there is no officially established public access (e.g., roads or trails) to the Mine Site (see Section 4.2.11.1), and thus no opportunity for recreational activity. No access (or recreational opportunities) would be allowed during construction, operation, or closure of the NorthMet Project Proposed Action. Accordingly, the NorthMet Project Proposed Action would have no effect on recreation within the Mine Site.

Construction and operation of the NorthMet Project Proposed Action would be entirely contained within the NorthMet Project area (i.e., the Mine Site, Transportation and Utility Corridor, and Plant Site). Thus, the NorthMet Project Proposed Action would not directly affect access to or use of regional recreational facilities such as other portions of the Superior National Forest, nearby parks and other public lands, or the BWCAW.

The public's enjoyment of recreational activities in the region—such as hunting, fishing, boating, hiking, and winter sports—is tied in part to visual resources, as discussed below, and also to a wide variety of factors evaluated in other sections of Chapter 5.0. Such factors include, but are not limited to, the availability and quality of fish and other aquatic species, vegetation, wildlife (particularly game species), noise, air quality, water quality, and wetlands. Effects on these resources are presented in the corresponding sections in Chapter 5.0.

The mine facilities such as mine pits, stockpiles, and associated facilities would be set back from most publicly-accessible land, including portions of the Superior National Forest south of the Transportation and Utility Corridor. In addition, the lack of designated trails in these portions of the Superior National Forest means that the number of recreational users who would approach the Mine Site would be limited. Nonetheless, the presence of the NorthMet Project Proposed Action would likely make recreational activities in the immediate vicinity of to the Mine Site, Transportation and Utility Corridor, and Plant Site less enjoyable (and therefore less likely) for some observers. In particular, three potential effects of the NorthMet Project Proposed Action could reduce recreational activity: noise, effects on fish populations (related to recreational fishing), and effects on wildlife populations (related to recreational hunting).

The presence of noise could discourage use of the portions of the Superior National Forest closest to the Mine Site and Plant Site (e.g., immediately south of the Transportation and Utility Corridor). Noise levels, including operational noise, ground vibration, and airblast overpressure, that exceed the most stringent category of state noise standards generally would not extend more than 0.84 mile from the Mine Site during the day and 2.3 miles at night (Figures 5.2.8-1 through 5.2.8-4).

The ROS classes for those portions of the Superior National Forest within 2.3 miles of the Mine Site are Semi-Primitive Motorized and Non-Motorized. NorthMet Project Proposed Action-related noise would affect up to 6,450 acres of the Superior National Forest within this 2.3 mile area. In these areas, project-related noise could limit full realization of the intended ROS classifications. Outside of the 2.3 mile area, NorthMet Project Proposed Action-related noise would not be inconsistent with ROS classes.

NorthMet Project Proposed Action-related noise, air emissions, and water discharges could potentially influence wildlife behavior in portions of the Superior National Forest closest to the Mine Site and Plant Site, as discussed in the wildlife Section 5.2.5. To the degree that game species are disturbed by NorthMet Project Proposed Action-related noise, they could choose to avoid this portion of the Superior National Forest, leading to reduced hunting opportunities in these areas. However, the area affected by noise is small, approximately 0.2 percent of the more than 3 million acres of the Superior National Forest. Species displaced by noise are likely to remain in surrounding areas of the Superior National Forest; overall opportunities for hunting and wildlife viewing on public lands in the region are not expected to change substantially.

Excluding effects related to noise, fisheries, air quality, and other effects described elsewhere in Chapter 5.0, and given the proximity of active and past mining and industrial activity to high-quality recreational activity in the Arrowhead region (such as the BWCAW), there is no evidence that the presence of the NorthMet Project Proposed Action in and of itself would affect the public's ability to hunt, fish, and conduct other recreational activities, or affect the overall recreational experience (apart from specific activities) in the Arrowhead region as a whole.

After closure, PolyMet would retain ownership of the Mine Site and the federal lands, and public access would likely remain restricted.

The Plant Site is located at the former LTVSMC processing plant. It is owned by PolyMet, and it is not open to the public. Entry roads are gated and/or guarded. No recreational activity is permitted at this site, nor would it be permitted during construction, operation, and closure of the NorthMet Project Proposed Action.

Visual Resources

At the Mine Site, the maximum height of the waste rock stockpiles would range from approximately 1,840 ft amsl (Category 1 Stockpile and Category 4 Stockpile) to 1,770 ft amsl (Category 2/3 Stockpile), or a maximum stockpile elevation of 180 to 240 ft above ground surface (PolyMet 2011e). The Giants Range rises sharply to the north of the Mine Site, blocking views of the mine, stockpiles, and safety lights (used when the stockpiles are active) from receptors to the north and west, including the BWCAW.

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 that could be visible in the night sky for viewers from the north. Light sources at the Mine Site would be similar to light levels at other mining projects across the Iron Range. For example, most of the lighting at the Mine Site will be directed downward, such as at the digging area in the case of the shovels and loaders, at the driving surface in the case of the haul trucks and locomotives, and at the dumping area at the stockpiles and the rail transfer hopper. The area around the blasthole drills will be illuminated so the drill can maneuver around the pattern. PolyMet does not propose any further specific mitigation measures with respect to light effects (PolyMet, Pers. Comm., July 25, 2012).

The upland forest surrounding the Mine Site to the east, south, and west would shield ground-level views of the Mine Site (including mine, stockpiles, and associated facilities) in those areas. These forest stands are a mix of coniferous and deciduous forests upwards of 60 ft in height and would provide year-round screening within several miles of the Mine Site (except, perhaps, from portions of the Superior National Forest that are very close to the southern boundary of the Transportation and Utility Corridor).

Viewers at elevated vistas to the south would have clearer views of the Mine Site. Figure 5.2.11-1 simulates the profile of the maximum extent of stockpiles (the largest visible component of the Mine Site) from the Skibo Vista Overlook on the Superior National Forest Scenic Byway, approximately 12 miles south-southwest of the Mine Site. Given the 180- to 240-ft height of the stockpiles, a portion of these would be visible above the treeline The stockpiles would not project above Giants Ridge or alter the silhouette of the skyline.

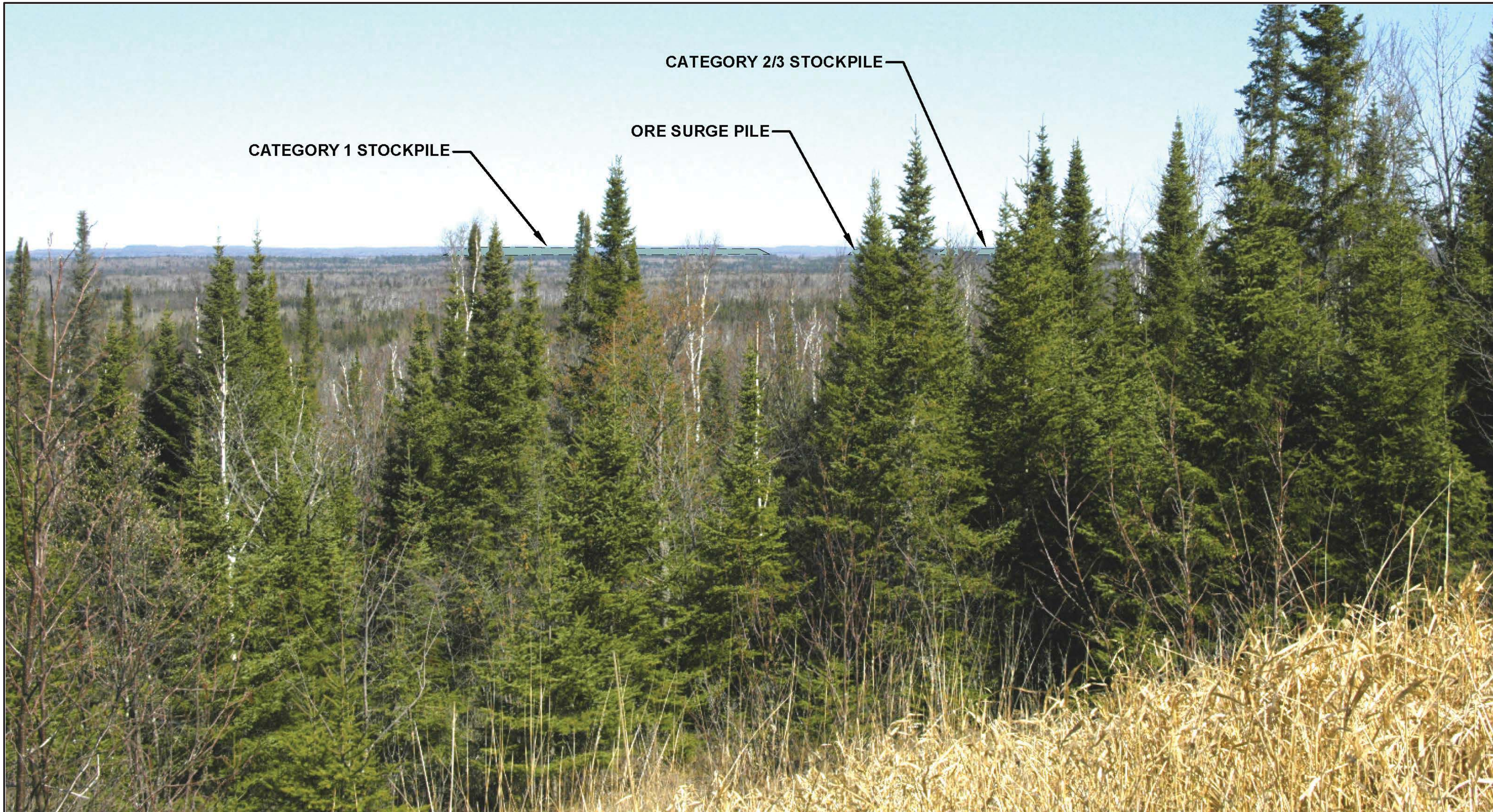

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Figure 5.2.11-1

Photo Simulation - View of Mine Site from Skibo Overlook

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Visual conditions would vary throughout the course of the mine's life. Initially, stockpiles would be less visible until heights exceed the surrounding treeline. The Category 2/3 Stockpile and Category 4 Stockpile would reach their maximum heights in year 11, after which they would be relocated into the East Pit. The Category 1 Stockpile would reach its maximum and permanent height in year 12 (excluding the cover material placed over the stockpile at mine closure). The height, shape, and coloring of the stockpiles would vary throughout the life of the mine; however, the coloring of the stockpiles would likely differ from the surrounding landscape, and would likely be more visible during winter months when screening from deciduous trees is at a minimum (although snow cover could tend to make the stockpiles look more like natural landforms). Viewers on elevated terrain to the east, north, or west of the Mine Site would generally have more limited views of the mine and stockpiles, although there could be sporadic direct views of the Mine Site, depending on exact location and vegetative screening

Mining and associated industrial activities are long-established aspects of the Mesabi Iron Range landscape. The NorthMet Project Proposed Action would introduce visual elements to the landscape that are similar to other active mines in the region, such as the adjacent Northshore Mine. However, these visual disturbances would occur in an area that, as shown in Figure 5.2.11-1, is currently vegetated.

In addition to the new visible components of the Mine Site and Plant Site (see below), mine construction, operations, and closure would likely generate some visible diesel and fugitive dust emissions from mine vehicles. Construction and closure emissions would likely be difficult to discern from the Skibo Vista Overlook and other distant viewpoints (see Section 5.2.7 for more details on anticipated emissions). As with the mine facilities themselves, construction emissions would generally be difficult to see from closer viewpoints due to the screening effect of terrain and vegetation.

Visual conditions are subjective and based in part on individual preferences. While many viewers consider any substantial disturbance of the existing landscape to be undesirable, some viewers find industrial sites visually compelling. While much of northeast Minnesota's recreation and tourist economy is based on high-quality wildlife, wilderness, and vegetation, there are distinct mine-related tourism resources. The Low SIO of the federal lands associated with the Mine Site indicates that the Mine Site is not intended to be a natural-looking landscape.

Following the completion of the mining activities, the PolyMet reclamation plan would remove all buildings and facilities at the Mine Site, and would revegetate disturbed areas with an approved vegetation mix. The Category 1 Stockpile would remain in place, and would also be vegetated, to the degree possible. This structure would be noticeable above the treeline, especially in winter, as shown in Figure 5.2.11-1. However, other similar stockpiles are found throughout the region. Over time, this feature would take on the appearance of a vegetated hill, and would blend in with the overall landscape.

No substantial changes are anticipated to the visual character of the Plant Site during NorthMet Project Proposed Action operations. The NorthMet Project Proposed Action would use, update, and expand existing infrastructure at the former LTVSMC processing plant, including an expanded Tailings Basin, additional hydrometallurgical processing facilities, and refurbished mill buildings. Figure 5.2.11-2 shows the current view of the Plant Site from Skibo Overlook. New structures constructed as a result of the NorthMet Project Proposed Action would not be visible from the overlook. During operations, steam plumes from the Plant Site would be visible under certain conditions, particularly from distant viewpoints such as Skibo Vista. To the degree that existing processing buildings are refurbished or removed (as appropriate), the NorthMet Project area would create the appearance of an active, maintained industrial site, rather than the current dilapidated appearance.

The Tailings Basin is visible to rural residences on County Road 358, located approximately 1 mile to the north of the Plant Site. The NorthMet Project Proposed Action would raise the elevation of Cells 1E and 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. These changes would not be out of character with the existing Tailings Basin, although the low silhouette of the Tailings Basin on the southern horizon would be noticeably expanded.

Through the closure process, all buildings and facilities at the Plant Site would be removed. At-grade (or below-grade) slabs and foundations will remain and will be covered with surface overburden. Most structures would be removed within three years of the start of closure, except for water treatment facilities necessary to maintain post-closure water quality standards. The Plant Site would be revegetated and seeded to promote a self-sustaining community of regionally-appropriate vegetation. As a result, the visual appearance of the Plant Site during and following closure would evolve rapidly from the operations-phase industrial character to a vegetated area that progressively becomes indistinguishable from adjacent vegetated areas.

5.2.11.3 NorthMet Project No Action Alternative

5.2.11.3.1 Recreation

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. The Mine Site would remain unchanged, and the USFS would continue to retain surface rights to the federal lands that comprise portions of the Mine Site. Given other private ownership (e.g., the Transportation and Utility Corridor), the federal lands would remain generally inaccessible to the public. There would be no direct or indirect effects on recreational activities at the Mine Site or the region’s surrounding recreational resources. Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed, and the Plant Site would remain off-limits to the public for recreation or other uses.

5.2.11.3.2 Visual Resources

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed, and would retain the Low SIO assigned by USFS. The Mine Site would remain unchanged, and there would be no effects on visual resources at the Mine Site. Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. The former LTVSMC process facility would be reclaimed, including building removal, in accordance with a separate closure plan. Reclamation activities could create a short-term disruption of the visual landscape, while long-term effects would be to reduce the developed nature of the site sooner than under the NorthMet Project Proposed Action.

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

Figure 5.2.11-2
Photo Simulation - View of Plant Site from Skibo Overlook
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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April 2013

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5.2.12 Wilderness and Other Special Designation Areas

Designations such as Wilderness or RNAs emphasize higher restrictions on human activity and access, while other designations, such as historic landmarks or scenic byways, emphasize management that seeks to enhance public enjoyment of certain spaces. Evaluating the effects on each type of designation considered how each set of characteristics or management objectives would be fundamentally changed by the NorthMet Project Proposed Action or the project alternatives. Potential effects could be from mining activity, or from anticipated changes in other human activity in areas in or near to wilderness or special designation areas due to the presence of the mining activity. No specific issues related to wilderness or special designations area were identified during public scoping.

Summary

The NorthMet Project Proposed Action would have no direct effects on wilderness or special designation areas. Air quality and water quality in these areas would be virtually unchanged from existing conditions; distance from activities associated with the NorthMet Project Proposed Action would leave ambient noise levels also unchanged. The absence of these direct effects means that there would be no indirect effects on wildlife, vegetation, or aquatic species. There could be a minimal effect on the Skibo Vista Scenic Outlook along the Superior National Forest Scenic Byway and therefore an associated indirect effect on recreation.

5.2.12.1 Methodology and Evaluation Criteria

This section uses data presented in Section 4.2.12 for all wilderness or special designation areas (including state parks) within a 25-mile radius of the NorthMet Project area. While no direct effects on wilderness character are anticipated due to changes in air quality, water quality or noise, recreation opportunities could be indirectly affected because of a small change in visual character.

For land that is or would be controlled by the USFS, the recreation evaluation criteria of the ROS system were used to determine indirect project effects (see Section 5.2.11.1.1).

5.2.12.2 NorthMet Project Proposed Action

Table 5.2.12-1 lists the Wilderness and Other Special Designation Areas within 25 miles of the NorthMet Project area and indicates significant features that have the most bearing on the potential effects of the NorthMet Project Proposed Action.

Table 5.2.12-1 Wilderness and Other Special Designation Areas within 25 miles of the NorthMet Project Proposed Action

Special Designation Area	Distance (miles) to the NorthMet Project Proposed Action	Significant Feature
Boundary Waters Canoe Area Wilderness	25	Laurentian Divide
Voyageurs National Park	20	Laurentian Divide
State Parks		
Soudan Underground Mine State Park	18	Watershed, topography, vegetation
Lake Vermillion State Park	16	Watershed, topography, vegetation
Iron Range Off-Highway State Park	11	Watershed, topography, vegetation
Bear Head Lake State Park	17	Watershed, topography, vegetation
Research Natural Areas		
Big Lake-Seven Beavers cRNA	12	Watershed, topography, vegetation
Keeley Creek RNA	25	Watershed, topography, vegetation
Dragon Lake cRNA	25	Watershed, topography, vegetation
Unique Biological Areas		
Little Isabella River UBA	25	Watershed, topography, vegetation
Harris Lake National Natural Landmark	20	Watershed, topography, vegetation
National Historic Landmark		
Soudan Iron Mine	18	Topography, vegetation
National Scenic Byway		
Superior National Forest Scenic Byway	9	Topography, vegetation
National Recreation Trail		
Taconite State Trail	15-17	Topography, vegetation

The table shows that all of the specially managed areas are well removed from project activities and generally would be screened by intervening topography and vegetation.

The NorthMet Project Proposed Action has demonstrated that effects associated with Class I Increment, visibility and sulfur dioxide effects on flora and fauna were all well below their respective significance levels at all Class I areas, including the BWCAW and Voyageurs National Park. In addition, all sulfur dioxide and sulfur deposition relating to terrestrial and aquatic settings were well below “green light” significance levels in these areas. Total nitrogen deposition effects approach their significance levels at the BWCAW (see Section 5.2.7.2).

Due to the presence of the Laurentian Divide, there will be no direct effects to waters of the BWCAW or Voyageurs National Park. The NorthMet Project area is in the Lake Superior Basin, while these two Class I areas are to the northeast of the Laurentian Divide where streams and rivers flow to the Hudson Bay Basin.

As described in Section 5.2.8, daytime noise standards for sensitive receptors would not be reached beyond 0.84 mile from the Mine Site and 0.47 mile from the Plant Site. The nighttime noise standards would not be exceeded beyond 2.3 miles from the Mine Site and 1.5 miles from the Plant site. The BCWAW and Voyageurs National Park, as well as the rest of the specially designated areas within 25 miles of the NorthMet Project area are all located at distances much greater than these ranges and so would not be expected to be directly affected by NorthMet Project Proposed Action-related noise. Nighttime views from the BCWAW toward the NorthMet Project area and nearby towns are such that light from the NorthMet Project Proposed Action would be indistinguishable from other sources of illumination.

Like the BCWAW and Voyageurs National Park, all of the state parks have been shown to be in areas where predicted concentrations are below secondary air standards that are designed to protect public welfare, including decreased visibility and damage to animals, crops, and vegetation. None of the state parks are within watersheds potentially affected by the NorthMet Project Proposed Action so there are neither direct effects on water quality nor indirect effects on aquatic species or wetlands.

Topography and vegetation screen the parks from view of the activities within NorthMet Project area, so there would be no direct effects on visual resources and no indirect effects on recreation.

The RNAs, cRNAs, and UBAs are also in watersheds not affected by the NorthMet Project Proposed Action so there will be no direct or indirect effects on surface water or groundwater in these areas. Topography and vegetation again screen these areas from view of the NorthMet Project Proposed Action-related activities so there are no direct effects on visual resources or indirect effects on recreation.

The Superior National Forest Scenic Byway is at a distance where it is unaffected by project-related noise. Similar to other specially designated resources, there will be no direct or indirect effects due to air quality or water quality. Most of the Byway is screened from view of the NorthMet Project Proposed Action by topography and vegetation. However, from Skibo Vista Scenic Overlook, which is approximately 12 miles south-southwest of the Mine Site, a portion of the stockpiles would be visible above the treeline. This direct effect would also mean a potentially small indirect effect on recreation.

By virtue of distance as well as topography and vegetation, the Taconite State Trail will experience neither direct nor indirect effects from the NorthMet Project Proposed Action.

5.2.12.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. The NorthMet Project No Action Alternative presents no anticipated effect on the BWCAW, Voyageurs National Park, Established and Candidate RNAs, UBAs, National Historic Landmarks, the Superior National Forest Scenic Byway, and a National Recreation Trail, as the Mine Site and portions of the federal lands would continue to be managed in the same way they have been.

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5.2.13 Hazardous Materials

Issues relating to the presence of hazardous materials or waste may include the accidental release of these materials during transportation, storage, handling, and/or use at the NorthMet Project area and any resulting potential effects on the environment. Environmental resources that could potentially be affected by hazardous materials and hazardous waste if they are accidentally released include: air, water, soil, and ecological resources. The area of potential effect therefore corresponds to the areas defined for each specific resource.

The NorthMet Project Proposed Action would use, or generate as waste, the following hazardous materials (Barr 2007e; Kevin Pylka, PolyMet, Pers. Comm., October 4, 2011; Kevin Pylka, PolyMet, Pers. Comm., May 11, 2012):

- fuels, equipment maintenance products, and solvents – diesel fuel, gasoline, oils, grease, lubricants, anti-freeze, solvents, and lead-acid batteries used for equipment operation and maintenance;
- plant reagents – sodium hydrosulfide, sodium hydroxide, acids, flocculants, and antiscalants used in processing plant applications;
- Mine Site WWTF chemicals – calcium hydroxide (hydrated lime), sodium metasilicate, ferric chloride, sodium hydroxide, polymer flocculent, carbon dioxide liquid, citric acid, and sodium hypochlorite ;
- Plant Site WWTP chemicals – potassium permanganate, antiscalant, carbon dioxide liquid, and calcium hydroxide (hydrated lime);
- blasting agents – ANFO, 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 characterized as hazardous waste.

Mishandling of these materials or wastes could result in spills, accidental release, or discharge into the environment, which could cause effects on workers, waters of the state, or the general public. Mitigation measures to prevent releases in transportation, storage, and handling or use of these materials are described in several hazardous material management plans necessary to comply with various regulatory requirements for the NorthMet Project Proposed Action. The following sections present the methodology and criteria used to estimate the risks to the public and environment from the use of hazardous materials and the generation of hazardous waste during the construction, operation, and closure phases of the NorthMet Project Proposed Action. The presentation is broken down into the major activities of transportation, storage, and handling and use.

Summary

Materials defined as hazardous are a routine part of mining and ore processing. Their handling, storage, and disposal are regulated by a number of state and federal laws. Adherence to these will limit the potential for off-site effects on only the transport of large quantities of hazardous materials. Transport routes have been defined that limit the potential for effects on population centers and sensitive resources. Given overall project design and operational commitments, there will be no significant adverse effects from the proposed use or generation of hazardous wastes by the NorthMet Project Proposed Action.

5.2.13.1 Evaluation Criteria

Several criteria are generally used in federal and State of Minnesota regulations and statutes to define the effects from an accidental spill, release, or discharge of contaminants or hazardous material or waste to the environment. The basic principle of these criteria is the protection of people and the environment. Based on this principle, the NorthMet Project Proposed Action would have an environmental effect if the following were to occur:

- a spill, release, or discharge of any hazardous material or hazardous waste during transportation that, if not recovered in a timely manner, could cause pollution of waters of the state, or other harm to the environment or to the public;
- a spill, release, or discharge of any hazardous material or hazardous waste during handling or use, which could cause pollution of waters of the state, or other harm to the environment or to the public;
- hazardous emissions from handling of any hazardous materials or hazardous waste that have the potential to cause harm to the public or the environment; and
- a spill, release, or discharge from on-site storage facilities exceeding the volumes of the primary and secondary containment structures, and which could not be recovered in a timely manner, and thus pollute waters of the state or cause other harm to the environment or to the public.

5.2.13.2 NorthMet Project Proposed Action

Federal and State of Minnesota regulations establish management and reporting requirements for hazardous materials. Based on current design, applicable administrative rules and statutes include the following:

- *Minnesota Statute* 115.061 – Duty to Notify and Avoid Water Pollution (*Minnesota Statues*, chapter 115, Water Pollution Control; Sanitary Districts);
- USEPA 40 CFR 355 – Emergency Planning and Notification, Subpart C – Emergency Release Notification (USEPA 40 CFR 300–399, Superfund; Emergency Planning; Community Right-to-Know Programs);
- USEPA 40 CFR 302 – Designation, Reportable Quantities, and Notification, Section 6 – Notification Requirements (USEPA 40 CFR 300–399, Superfund; Emergency Planning; Community Right-to-Know Programs);
- USEPA 40 CFR 112 – Oil Pollution Prevention (USEPA 40 CFR 100–149, Water Programs);
- USEPA 40 CFR 68 – Chemical Accident Prevention Provisions (USEPA 40 CFR 70–99, Air Programs II);
- USEPA Clean Air Act, Section 112(b) – Hazardous Air Pollutants (42 USC chapter 85, Air Pollution Prevention and Control);

- USEPA 40 CFR 355–372 – EPCRA (USEPA 40 CFR 300–399, Superfund; Emergency Planning; Community Right to Know Programs);
- OSHA 29 CFR 1910.120 – Hazardous Waste Operations and Emergency Response (OSHA 29 CFR 1900–1910);
- DOT 49 CFR 100–180 – Hazardous Materials Transportation (Hazardous Materials Transportation 49 CFR 100–180, Chapter I, Pipeline and Hazardous Materials Safety Administration, DOT);
- MSHA Rule 30 CFR Part 47 Hazard Communication (Mine Safety Administration 30 CFR 1–199);
- Minnesota Statutes, Chapter 115 and Chapters 115A–115E – Water Pollution Control, through Oil and Hazardous Substance Discharge Preparedness (Minnesota Statues, chapter 115, Water Pollution Control; Sanitary Districts);
- *Minnesota Rules*, Chapter 7151 – Aboveground Storage of Liquid Substances (*Minnesota Rules*, MPCA, chapter 7151);
- *Minnesota Rules*, Chapters 7045–7048 – Hazardous Waste (*Minnesota Rules*, MPCA, chapter 7045–7048);
- *Minnesota Rules*, Chapters 7507 and 7513 – Hazardous Materials (*Minnesota Rules*, MPCA, chapter 7507–7513);
- *Minnesota Rules*, Chapter 7035 – Solid Waste (*Minnesota Rules*, MPCA, chapter 7035); and
- *Minnesota Rules*, Chapter 6132 – Nonferrous Metallic Mineral Mining (*Minnesota Rules*, Department of Natural Resources, chapter 6132).

A list of the larger quantity hazardous materials transported, stored, handled, recycled, or disposed, and their classifications, that will be associated with the NorthMet Project Proposed Action construction, operation, and closure is provided in Table 5.2.13-1. The estimated delivery frequency, volumes, and annual use of these materials are also listed in Table 5.2.13-1.

Table 5.2.13-1 Hazardous Materials used during Construction, Operation, and Closure Phases of the NorthMet Project Proposed Action

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Deliveries (Estimated Frequency) Approximate Rate	Annual Use (Est.)
ANFO	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.	No on-site storage. Vendor provided on a daily basis.	Vendor/truck	883,333 lbs/month	10,600,000 lbs/year
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 affect aquatic animals.	No on-site storage. Vendor provided on a daily basis.	Vendor/truck	1,555/month	18,650/year
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 affect aquatic animals.	No on-site storage. Vendor provided on a daily basis.	Vendor/truck	387,500 lbs/month	4,650,000 lbs/year
Diesel fuel	Flammable: Continued exposure to vapors can irritate eyes and lungs. Potentially fatal if ingested.	Any spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released 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 (volume/ tanker truck = 5,500-9,000 gal)	74 tanker truck loads/month	<u>Mine:</u> 5,910,000 gal/year <u>Plant:</u> Uncertain, but relatively minor <u>Locomotives:</u> 473,040 gal/year

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Deliveries (Estimated Frequency) Approximate Rate	Annual Use (Est.)
Grease (385 lbs/55-gallon drum)	Mild skin irritant, ingestion may cause discomfort.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Existing bulk storage at Area 1 and Area 2 Shops.	55-gal drums	<1 truck/month	Mine: Unknown Plant: Uncertain, but relatively minor Locomotives: 16 lb/year – each locomotive
Lubricating Oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Mine: 2,000 gal Plant: 2 – 7,000 gal 2 – 12,000 gal 1 – 12,338 gal	Tanker truck (typically <3,000 gal/tanker truck)	2 tanker truck loads/month	Mine: 47,000 gal/year Plant: Uncertain, but relatively minor Locomotives: 200 gal/year – each locomotive
Transmission oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Mine: 1,500 gal	Tanker truck (typically <3,000 gal/tanker truck)	< 2 loads/month	Mine: 33,000 gal/year

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency): Means	Deliveries (Estimated Frequency): Approximate Rate	Annual Use (Est.)
Hydraulic oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released 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 (typically <3,000 gal/tanker truck)	< 1 load/month	Mine: 13,000 gal/year 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	55-gal drums and tanker truck (typically <3,000 gal/tanker truck)	1 delivery/month	Mine: 12,000 gal/year Plant: Uncertain, but relatively minor
Gasoline (light vehicles)	Harmful or fatal if swallowed; eye, skin, and respiratory irritant.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Plant: 2 - 6,000 gal	Tanker truck (typically <3,000 gal/tanker truck)	2 deliveries/month	Plant: 500 gal/day or 178,000 gal/year
Degreaser	Skin and eye irritant, potential inhalation hazard.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals. Should not be released undiluted into the environment.	Plant: 1 - 400 gal 1 - 2,500 gal	55-gal drums and/or tanker truck (typically <3,000 gal/tanker truck)	As needed to keep full; < 1 delivery/month	Uncertain, likely less than 15,000 gal/year

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Deliveries (Estimated Frequency) Approximate Rate	Annual Use (Est.)
Used oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	55-gal drums or storage tank	Not Applicable	Removed from site as needed typically by vendor with bulk tank truck; approximately 2 times/month	Mine: 47,000 gal/year Plant: Uncertain, but relatively minor Locomotives: 200 gal/year – each locomotive
Caustic (NaOH) (assume 10.7 lbs/gal)	Skin and eye irritant, corrosive.	No known environmental effects.	1,100-gal storage tank	Tanker truck (typically <3,000 gal/tanker truck)	1 load/month	64 t/year
Flocculent (MagnaFloc 10)	Inhalation irritant.	No known environmental effects.	1,875-lb bulk bags	Freight truck	1 truck/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 truck	< 1 truck/month	26 t/year
Flocculent (MagnaFloc 351)	Low overall toxicity.	No known environmental effects.	1,875-lb bulk bags of powder	Freight truck	<1 truck/month	179 t/year
Sulfuric Acid (assume 15 lbs/gal)	Skin and eye irritant, corrosive.	Toxic to some species of fish if released into waters.	78,700-gal storage tank with secondary containment	Bulk rail tank car (13,000-gal or 98-t capacity)	2 tank cars/year	138 t/year
Hydrochloric Acid (assume 10 lbs/gal)	Skin and eye irritant, corrosive.	If released into the soil, this material is not expected to bio-degrade and may leach into groundwater.	59,500-gal storage tank with secondary containment	Bulk rail tank car (13,000-gal or 65-t capacity)	2 tank cars/month	1,485 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-gal pressurized storage tank with secondary containment	Bulk rail tank car (15-55 t/car)	2 tank cars/month	1,254 t/year

				Deliveries (Estimated Frequency)		
Material	**Classifications & Precautions****	**Environmental Concern**	**Storage Capacity**	**Means**	**Approximate Rate**	**Annual Use (Est.)**
Sodium Hydrosulfide (assume 11 lbs/gal)	Extremely corrosive to exposed tissues. Contact with acid releases toxic gas. DOT corrosive.	Toxic to aquatic organisms if released into waters.	52,600-gal storage tank	Tanker truck (volume/tanker truck = 5,500-9,000 gal;	< 1 tanker/month	334 t/year
Potassium Amyl Xanthate (PAX)	DOT spontaneously combustible. Mild irritant. Heating and moisture produces H_2S, 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.	~30,000-gal storage tank	1,650-lb bulk bags, 25 bags/truck load	~5 trucks/month	1,075 t/year
Methyl Isobutyl Carbinol (assume 6.72 lbs/gal)	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.	~10,000-gal storage tank	Tanker truck (volume/tanker truck = 5,500-9,000 gal)	~ 6 trucks/month	1,124 t/year
Limestone	Harmful if swallowed; eye, skin, and respiratory irritant.	Airborne particulates may cause some harm to environment dependent on concentrations.	Bulk - stockpiled on site	Bulk rail car (70-110 t/rail car)	Up to 100 rail cars/week from April to October	87,341 t/year
Lime	Eye and skin irritant; harmful if swallowed. Avoid breathing vapor or dust.	Possibly hazardous in the short term. Degradation products are not likely; however, long term degradation products may arise.	Bulk - lime silo	Freight truck (20 – 25 t/truck)	15 loads/month	5,181 t/year
Magnesium Hydroxide	Harmful if swallowed; eye, skin, and respiratory irritant.	Possibly hazardous in the short term. Degradation products are not likely; however, long term degradation products may arise.	Storage tank	Bulk rail car (65 – 104 t/rail car)	3 tank cars/month	3,674 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 (100 t/rail car)	13 rail cars/month	15,600 t/year

				Deliveries (Estimated Frequency)		
Material	**Classifications & Precautions****	**Environmental Concern**	**Storage Capacity**	**Means**	**Approximate Rate**	**Annual Use (Est.)**
Flotation Activators (copper sulfate)	Harmful if swallowed; eye and respiratory irritant.	Toxic to fish and plants if released into waters.	9,200-gal activator storage tank	Reuse from Oxidation Autoclave	Not applicable	650 t/year
Ferric Chloride (35%)	Very hazardous if ingested; corrosive to eyes and skin; respiratory irritant.	Mutagen; harmful to fish and invertebrates; reproductive effects, low potential for bio-accumulation; no information regarding environmental fate or toxicity.	6,000- and 1,000-gal storage tank	Tanker truck (typically <3,000 gal/tanker truck)	1,200 gal/month	14,400 gal/year
Potassium Permanganate	Eye and skin irritant; respiratory irritant	Mutagen; ecological information not available.	Bulk (dry)	Freight truck	1,300 lbs/month	16,000 lbs/year
Liquid Carbon Dioxide	Gas is an asphyxiant; prolonged skin or eye contact to gas, liquid or solid (crystals) may cause severe frostbite;	No adverse effects; carbon dioxide does not contain Class I or II ozone depleting chemicals.	Bulk (liquefied gas)	Tanker (cylinder) truck	105 t/month	1250 t/year

Note: t = short tons; equal to 2,000 lbs.

The United Nations hazard classification system for classifying explosive materials and explosive components is recognized internationally and is used universally by the Department of Defense, Department of Energy contractors, and the DOT. UN numbers however, are different from the hazard class and division designations used by the Department of Transportation.

Hazard Classification 1.1D and 1.5D: 1.1 is a Hazard Class division for Class 1 (Explosives) and is defined as a Mass Detonation Hazard. It is expected that if one item in a container or pallet inadvertently detonates, the explosion will sympathetically detonate the surrounding items. The explosion could propagate to all or the majority of the items stored together, causing a mass detonation. There will also be fragments from the item's casing and/or structures in the blast area. Hazard Class division 1.5 is an Explosive substance, very insensitive (with a mass explosion hazard).

The "D" is the Class 1 Compatibility Group defined as the secondary detonating explosive substance or black powder or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features (UNO 2012).

**Precautions are described as indicated by the National Institute for Occupational Safety and Health (NIOSH 2012), or those described in chemical-specific Material Safety Data Sheets (Montana Refining Company 2011), (Dow 2009), (EDS 2009a), (CSCC 2005), (EDS 2009b), (Praxair Technology 2009b), (Flottec 2009), (Martin Marietta Materials 2007), (Western Lime Corporation 2009), (AluChem 2010), (Old Bridge Chemicals 1999), (H-Valley Chemical 2006), (ClearTech Industries 2010), and (Praxair Technology 2009a).

Material, Storage Capacity, Delivery Means, Delivery Approximate Rate, and Annual Use Estimate (Kevin Pylka, PolyMet, Pers. Comm., October 4, 2011), (Kevin Pylka, PolyMet, Pers. Comm., May 11, 2012)).

5.2.13.2.1 Transportation

All hazardous materials would be transported by commercial carriers in accordance with state and federal hazardous material shipping requirements. Such carriers would be licensed and inspected by the Minnesota DOT. Tanker trucks would possess a Certificate of Compliance issued by the Minnesota Motor Vehicle Division. These permits, licenses, and certificates would be 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 MSDSs that describe 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.

Hazardous waste would also be transported from the Mine Site and Plant Site for proper disposal. Transportation of these wastes would require compliance with state and federal regulations that include requirements for hazardous waste manifests with the shipments, labeling, and/or use of placards, and emergency information. PolyMet employees would be trained to manage all wastes in accordance with their specific job duties. Transportation of hazardous waste would be conducted by vendors also licensed and trained to manage hazardous waste.

As identified in Table 5.2.13-1, trucks would be used to transport a variety of hazardous materials to the Mine Site and Plant Site. Shipments of hazardous materials would originate from a number of locations. The risk of accidental truck spills was evaluated using two representative hazardous materials, diesel fuel and PAX, due to the relatively large number of deliveries and health risks associated with these materials (Rhyne 1994). Approximately 74 tanker truck loads of diesel fuel and 5 truckloads of PAX would be delivered monthly. These quantities would amount to approximately 17,800 and 1,200 shipments of diesel fuel and PAX, respectively, based on 20 years of estimated mine life.

For this evaluation, materials were assumed to be shipped from Duluth. These materials would be transported approximately 60 miles along State Highway 53 (four-lane divided highway) from Duluth to Eveleth, and then approximately 20 miles along State Highways 37 and 135 (two-lane highways) from Eveleth to the North Gate access road to the site. This route would take the materials through the towns of Duluth, Twig, Independence, Canyon, Cotton, Central Lakes, Eveleth, Gilbert, Biwabik, and Pineville and across the Cloquet, Whiteface, St Louis, and Embarrass rivers and Paleface Creek. These state highways already provide transportation routes for freight that includes hazardous materials and waste. St. Louis County Emergency Services are available for response to incidents associated with hazardous materials due to the current transport of these materials from existing businesses that use hazardous materials or generate hazardous waste within their operations. Emergency response services vary from medical rescue and ambulance services to fire-fighting and local HazMat-trained response teams stationed in various cities or districts along the defined transportation route. The locations of emergency response services are identified in multiple sectors within the county as defined by the St. Louis County Hazard Mitigation Plan prepared by the St. Louis County Emergency Management division of the St Louis County Sheriff’s Office (St. Louis County 2005). The HazMat Response Team is stationed in Duluth.

The effect of an accidental release would depend on the location in relation to population, local activities, the quantity released, environmental factors, and the nature of the released material. The probability of an accidental release of the representative hazardous materials described above during transportation was calculated using the Federal Highway Administration truck accident statistics model (Rhyne 1994) as presented in Table 5.2.13-2. The definition of hazardous materials, 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." According to these statistics, the average rate of truck accidents for transport along a rural interstate highway, such as State Highway 53, is 0.64 per million miles traveled. For rural two-lane highways, such as State Highways 37 and 135, the average truck accident rate is 2.19 accidents per million miles traveled.

Table 5.2.13-2 Release Probability of Representative Materials Transported during Construction, Operation, and Closure Phases of the NorthMet Project Proposed Action

	Rural State/Interstate Highway (four lane)						Rural State Highway (two lane)						
Material Transported	**No. of Truck Deliveries**	**Haul Distance (Miles)**	**Accident Rate Per Million Miles Traveled**	**Calculated Number of Accidents**	**Probability of Release Given an Accident (%)**	**Calculated Number of Spills**	**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	17,800.0	60.0	0.64	0.68352	18.8	0.12850	17,800.0	20.0	2.19	0.77964	18.8	0.14657	0.27
PAX	1,200.0	60.0	0.64	0.04608	18.8	0.00866	1,200.0	20.0	2.19	0.05256	18.8	0.00988	0.018

Source: Federal Highway Administration truck accident statistics model (Rhyne 1994).

The probability of a release or spill was based on accident statistics for liquid tankers carrying hazardous materials. The Federal Highway Administration statistics indicate that on average, 18.8 percent of the total accidents involving liquid tankers carrying hazardous materials resulted in a spill or release.

Using the accident and liquid tanker spill statistics, the evaluation indicates that the probability for an accidental release of liquids under truck transport during the life of the NorthMet Project Proposed Action is less than one spill accident for each of the representative materials considered. The release probability indicates there is a 1.8 percent probability of an accident resulting in a release of PAX, and a 27 percent probability of an accident resulting in a release of diesel fuel that could occur over the entire 20-year life of the NorthMet Project Proposed Action. The higher probability of a diesel fuel accident is due to the greater expected number of diesel fuel deliveries to the site.

The odds of a potential release of hazardous materials during a transportation accident would incrementally increase if the other shipments listed in Table 5.2.13-1 were included. An accidental release could range from a minor oil spill at the Mine Site and Plant Site, where cleanup equipment would be readily available, to a severe spill during transport involving a large release of diesel fuel or other hazardous material, where emergency cleanup equipment would not be readily available. 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. Considering the overall risk of an accident involving a spill, and the anticipated transport routes, the probability of a spill into a waterway would be moderate. An alternative transportation route, shorter by about 17 miles, was evaluated but rejected because of its close proximity to water bodies such as Wild Rice and Island lakes. The transportation route selected for this evaluation is longer, but is farther away from water bodies, so in the event that an accidental spill or release of materials occurs, it could be managed in a more timely manner to reduce the likelihood of environmental harm. A shorter route could be used, but the probability of effect on a water body would be greater due to the proximity of the water bodies.

A large-scale release of hazardous liquids delivered to the site by tanker truck (9,000-gallon capacity) or rail car (up to 13,000-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 potential effects. As indicated in Table 5.2.13-2, the probability of a release anywhere along a proposed transportation route was calculated to be low. Review of the Hazmat Intelligence Portal of the U.S. DOT indicates that the likelihood of a bulk rail incident is 40 percent less than that of a highway incident (PHMSA 2012b). The likelihood of a rail incident, when all incidents are included, is 82 percent less than that of a highway incident (PHMSA 2012a).

In addition to location, the potential harm presented by the material released is a factor in determining the effect of a release. A qualitative evaluation of the materials to be shipped indicates that the probability of causing 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 a 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, emergency response would be undertaken to prevent or minimize exposure, 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, fire protection, and emergency planning agencies would also mobilize 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) (Hazardous Materials Transportation 49 CFR 100–180, Chapter I, Pipeline And Hazardous Materials Safety Administration, DOT). Minnesota Statutes require notification of the Minnesota State Duty Officer (Minnesota Statues, chapter 115, Water Pollution Control). PolyMet and its hazardous material handlers and/or DOT-regulated contractors would be required to comply with these and similar regulatory requirements, which also stipulate emergency planning and response actions.

5.2.13.2.2 Storage

The approximate capacities of hazardous material storage tanks that would be at the NorthMet Project area are listed in Table 5.2.13-1. 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 NorthMet Project Proposed Action specifications. Tanks and vessels would be positioned on approved secondary containment with interior sumps to route spilled products or process solutions to lined collection areas. In addition, hazardous materials would be unloaded on an approved containment surface with sumps to route spills to lined collection areas. Some of the hazardous material storage tanks at the Mine Site would be double-walled for provision of secondary containment. Mine Site hazardous material storage tanks without double-walls and Plant Site hazardous material storage tanks would be designed to 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 oil, hazardous waste, and spent hazardous materials would be managed by PolyMet employees while on site, and shipped off site for recycling or disposal using a DOT-licensed transporter. In addition, fire assay wastes—including cupels, crucibles, and slag—would be managed by PolyMet employees while on site and shipped off site for recycling or disposal at a licensed facility using a DOT-licensed transporter. Certain materials may be stored on site for a period before shipment. These materials would be stored in compliance with safety storage requirements as dictated by state and federal requirements. The storage period would also comply with Minnesota and federal storage timeline stipulations. All stored wastes would be appropriately labeled and dated for timeline inspection purposes.

5.2.13.2.3 Handling and Use

Over the life of the NorthMet Project Proposed Action, the probability of minor spills of oils and lubricants would be relatively high. Releases could occur during operations because of a poor connection of an oil or hydraulic line, or as the result of equipment failure. Effects of such minor spills could include contamination of surface water and soil; however, spills of this nature would likely be small, localized, and contained.

Some of these spills may be reportable. In Minnesota, spills or discharges of more than 5 gallons of petroleum products or any quantity of chemicals or materials, whether accidental or otherwise, are required by law to be reported to the Minnesota State Duty Officer at the MPCA, by the person with control of the spill, which, if not recovered, may cause pollution of waters of the state. The responsible NorthMet Project Proposed Action person is required to recover as rapidly and thoroughly as possible such spilled material, and take immediate action as reasonably possible to minimize or abate pollution of waters of the state (Minnesota Statutes, section 115.061, Duty to Notify and Avoid Water Pollution).

Emergency release notification requirements under EPCRA (USEPA 40 CFR, chapter 355) exist in addition to the release notification requirements of CERCLA (USEPA 40 CFR, chapter 302). If the NorthMet Project Proposed Action had a release of a CERCLA hazardous substance, it would be required to comply with the notification requirements of EPCRA, and the release notification requirements of CERCLA. If the reportable quantity of a substance were released within a 24-hour period at the NorthMet Project area, and the substance was on the list of extremely hazardous substances under EPCRA or the list of CERCLA hazardous substances (USEPA 40 CFR, chapter 302.4), then PolyMet would be subject to reporting requirements described in 40 CFR 355.60, 40 CFR 302, and the Emergency Notification Procedures in Minnesota as required by Title III of the Superfund Amendments and Reauthorization Act (USEPA 40 CFR, chapters 300 to 399).

The requirements for storage of oils and lubricants, including the requirement for SPCC planning are found in the Oil Pollution Prevention Act (USEPA 40 CFR, chapter 112) and MN § 115E (Minnesota Statues, chapter 115, Water Pollution Control; Sanitary Districts). Applicable Minnesota Statutes include: Prevention and Response Plans (Section 115E.04), Response Plans for Tank Facilities (Section 115E.045, Subdivision 2), and Responses to Releases (Section 115C.03). A list of hazardous material management and response plans is presented in Table 5.2.13-3.

Table 5.2.13-3 Hazardous Material Management Plans

Plans	Applicable Statute/Regulation	Materials/Applications
SPCC Plan	USEPA 40 CFR chapter 112	Oil/petroleum spills
Toxic Pollution Prevention Plan	Minnesota Statutes, chapter 115D Subdivision 1(a) USEPA 40 CFR 260 - 279 DOT 49 CFR	Waste minimization, handling, storage, disposal, recycling of hazardous substances, chemicals, fluids, and other wastes. Transportation of hazardous materials.
Hazard Communications 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	OSHA 29 CFR 1910.120 USEPA 40 CFR 68	Hazardous material release response guidance.
Spill Prevention/Response Plan	29 CFR 1910.120/CAA Section 112 Minnesota Statutes, chapter 115E (may also be applicable to trucking vendors)	General guidance Minnesota state guideline for responding to spills and releases.
Risk Management Program	USEPA 40 CFR 68	Hazard assessment, accident history, prevention program and training, and emergency response program.

The threshold quantity, as defined in 40 CFR 112, for triggering the requirement for development of a SPCC plan is 1,320 gallons of petroleum products in bulk container storage greater than 55 gallons. Since the NorthMet Project area would have more than 1,320 but less than 1,000,000 gallons of oil storage, an SPCC plan would be required under 40 CFR 112. The primary goal of an SPCC plan is to develop strategies to prevent oil spills from reaching Minnesota and United States waters. An SPCC plan is thus specific to each facility, providing persons responsible for planning emergency response site-specific information such as a description of facilities, storage information, preventative measures, response action, equipment, and contact information. An SPCC plan must also provide information for routine facility inspections.

To reduce the likelihood of incidental spills of petroleum products, a preliminary SPCC plan has been prepared for the NorthMet Project Proposed Action. The plan identifies potential emergencies that may arise during operations or an activity within the NorthMet Project area. The plan establishes a framework to respond effectively to the identified potential emergencies.

The final SPCC plan would include procedures, methods, equipment, and other requirements to prevent discharges of oil from facilities, and to contain such discharges, should they occur. The SPCC plan would also contain a detailed, facility-specific description of how the operations comply with the requirements of the Oil Pollution Prevention regulation (USEPA 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, liquid level devices, and emergency shut-off or release alarms. The final SPCC plan must be certified by a Professional Engineer that in their professional judgment the following are true:

- 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 practices, including consideration of applicable industry practice.

A final SPCC plan is not possible for the NorthMet Project Proposed Action until construction has been completed. However, PolyMet has prepared a preliminary SPCC plan that is compliant with 40 CFR 112 requirements.

The policies and procedures set forth in the SPCC plan, inclusive of PolyMet's Standard Operating Procedure for Storage Tank Management, would be prepared to comply with *Minnesota Rules*, Chapter 7151, Aboveground Storage of Liquid Materials.

The preliminary SPCC plan would be finalized and certified by a Professional Engineer, as required, after petroleum storage and handling facilities have been constructed. Based on current planning information, the final 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;

- large-quantity 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 or license, and the waste would be transported to a recycling, treatment, or disposal facility. One fueling station would typically be provided to fuel all mobile equipment with rubber tires (trucks, dumps, front end loaders, dozers, etc.). This equipment also may be fueled in place by remote fuel tankers. Remote fueling typically would be conducted for equipment located within the mine pits and at material stockpiles (e.g., excavators, dozers, and other tracked equipment). Portable spill clean-up kits would be available at the fueling stations and on the fuel tankers. Standard operating procedures, including spill response plans, would be prepared and associated training would be conducted for fueling operations. Equipment would be attended during fueling operations. When possible, remote fueling would not be performed near sensitive areas, where, if a release were to occur, surface water could be affected. At final design stage, an updated or final version of the current SPCC plan would be prepared for the NorthMet Project Proposed Action facilities, to address specific spill response, cleanup, release notifications, etc. For oil-filled equipment, an appropriate containment system would be constructed so that 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 that define inspections and/or a monitoring program to detect equipment requiring service or failure, and/or discharge. ASTs would be located at the truck fueling station where fuel storage would meet secondary containment standards. The tanks would have a containment dike with 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 MSDSs, would be available in all areas where hazardous materials were expected to be used or produced, and at all areas of fuel and lube-oil storage.

5.2.13.2.4 Emergency Planning and Community Right-to-Know

Management of hazardous materials at the NorthMet Project area would be governed by a number of interrelated federal, state, and local regulations, as listed in the first part of this Hazardous Materials Section. The following discusses federal and Minnesota state actions under EPCRA, including its emergency response-planning activities, Hazardous Chemical Inventory Reporting (Tier II) requirements, and TRI reporting requirements. Minnesota's hazardous materials regulations are codified in the *Minnesota Rules*, chapters 7507 and 7513, and in Minnesota Statute, chapter 299K.

As required by EPCRA, Minnesota has established the Minnesota ERC, an agency within the Minnesota Department of Public Safety, Division of Homeland Security and Emergency Management. The Minnesota ERC coordinates information specific to hazardous materials at facilities around the state so that local emergency officials are able to prepare for emergencies. The Minnesota ERC serves as the repository for the EPCRA hazardous chemical inventory reports (Tier II reports). Along with the listing of hazardous materials identified on Table

5.2.13-1, PolyMet would prepare and submit Tier II Emergency and Hazardous Chemical Inventory Report Forms for sodium hydroxide, hydrochloric acid, sodium hydroxide, sulfuric acid, and SO_2, and would be subject to reporting additional hazardous materials or chemicals maintained on site in quantities greater than the Tier II reporting thresholds.

The Minnesota ERC also collects data from facilities reporting under the federal TRI report program mandated by SARA Title III, Section 313. The NorthMet Project Proposed Action would be subject to TRI reporting based on the quantities of sulfuric acid and SO_2 to be maintained at the NorthMet Project area and could include others depending on actual quantities.

Under the federal Pollution Prevention Act of 1990, facilities subject to TRI reporting must also provide information on the pollution prevention and recycling activities associated with the reported toxic chemicals. The NorthMet Project Proposed Action would be subject to Minnesota's Toxic Pollution Prevention Act (Minnesota Statutes, section 115D.07), and PolyMet would have to prepare a TPPP. The TPPP would describe the facility's processes and operations, and set objectives for the handling, storage, and disposal or recycling of hazardous materials and toxic chemicals to eliminate or reduce at the source, the use, generation, or release of toxic pollutants, hazardous substances, materials, and hazardous wastes.

Under the federal CAA Amendments of 1990 Section 112(r), the NorthMet Project Proposed Action would be subject to the Accidental Release Prevention/Risk Management Plan rule, based on the projected use of hydrochloric acid and other flammable and toxic substances (42 USC, chapter 85, Air Pollution Prevention and Control). PolyMet would be required to develop a Risk Management Program that would include:

- hazard assessment and potential effects of an accidental release, accident history, and evaluation of worst-case and accidental release scenarios;
- prevention program including safety precautions, maintenance, monitoring, and training measures; and
- emergency response program detailing emergency health care, training, and procedures for informing the public and response agencies should an accident occur.

The hazardous material management plans include procedures for evacuating personnel, maintaining safety, cleanup, neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation. Proper implementation of the SPCC plan, TPPP, Hazard Communications, Emergency Response Plan, Spill Response Plans, and the Risk Management Program would minimize the incidents and effects associated with potential releases of hazardous materials.

If present, cobalt-60 and other hazardous or potentially hazardous materials or wastes would be characterized and managed per the hazardous materials management plans described in Table 5.2.13-3 above, and, if applicable, would adhere to the requirements defined in *Minnesota Rules*, chapter 7045, Hazardous Waste.

5.2.13.3 Potential Mitigation Measures

Mitigation of a hazardous material release would follow the principle of prevention, minimization, and treatment. Prevention would be achieved when any hazardous material was avoided, where possible, by replacing it with a substitute material that was not hazardous. To the extent possible, this has been done; where not possible, precautions to be defined in the TPPP would be taken to properly manage hazardous materials or substances, and keep the potential risk of exposure to a minimum. Accidentally released hazardous material would be treated quickly in accordance with the described plans.

In addition, mitigation processes or procedure definitions would be included in the following:

- hazardous communication materials, through communications and training programs;
- overfill protection procedures;
- provision for secondary containment;
- establishment of leak detection systems;
- preventative inspection and maintenance procedures; and
- emergency response plan.

These measures would be designed to ensure that accidental releases were prevented or minimized, and when they did occur, were responded to quickly and properly.

Monitoring activities proposed for prevention of incidental releases, mitigation, or quick removal of the effects, if hazardous materials were released, include the following:

- regular inspection and testing 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;
- maintaining MSDS sheets at visible locations for easy access at all times; and
- regular monitoring of surface water and groundwater quality.

Monitoring and inspection would be an integral part of the hazardous material management processes at the NorthMet Project area.

Given current project design and operational commitments, this analysis did not identify significant adverse effects from proposed hazardous materials use or hazardous waste generation by the NorthMet Project Proposed Action. Therefore, no additional mitigation measures are proposed.

5.2.13.4 NorthMet Project No Action Alternative

The NorthMet Project No Action Alternative has no risk of environmental effect since no hazardous materials would be used, and no hazardous waste would be generated under this alternative.

5.2.14 Geotechnical Stability

The geotechnical stability of the proposed large-scale material storage facilities for the NorthMet Project Proposed Action is addressed in this section. These facilities are the new waste rock stockpiles that would be created at the Mine Site; the Tailings Basin, which would be constructed on top of the existing LTVSMC Tailings Basin; and the Hydrometallurgical Residue Facility, which would be constructed at the existing LTVSMC Emergency Basin.

This section provides a summary of the required design criteria and the methodology and results of the iterative model and design process, as well as an overview of the proposed monitoring and mitigation measures.

Summary

Conceptual designs of the waste rock stockpiles, Tailings Basin, and Hydrometallurgical Residue Facility have been developed and shown by PolyMet, through an iterative design and model process, to meet the minimum safety factors and water quality criteria (Section 5.2.2) acceptable to the Co-lead Agencies. The structural integrity of these facilities would be monitored throughout operations and long-term closure. This approach would allow for identification of a need to implement adaptive mitigation measures as a contingency to further improve stability should the facilities perform differently from their designed and predicted performance.

5.2.14.1 Methodology and Evaluation Criteria

The direct environmental consequences of the proposed large-scale waste material storage facilities, including the disturbance footprint and water effects, are discussed under the respective environmental factors in Chapter 5.0. This section addresses the structural integrity of the proposed facilities.

If incorrectly designed, constructed, and/or managed, waste material storage facilities would have the potential to result in increased hydrologic and/or water quality effects and may be unstable (potentially leading to slope or dam failure).

The large-scale waste material storage facilities proposed for the NorthMet Project Proposed Action would require compliance with MDNR, nonferrous mining, and dam safety rules, as well as the MPCA SDS Permit. The permits require that design and safety criteria be met to reduce the risk of potential failure.

The design of geotechnical features is typically developed using an iterative design and model approach where the design is amended until modeling results meet the required minimum design criteria, including Factors of Safety and other requirements for permitting. Factor of Safety is used to describe the structural capacity of a system, whereby a Factor of Safety of 1.0 represents the structural capacity that is just on the margin of providing the required intended load, and a Factor of Safety of 1.2 represents a structural capacity to hold 120 percent of the intended load. Systems are often purposefully built stronger than needed for the intended load (i.e., to have a greater Factor of Safety than 1.0 to allow for emergency situations, unexpected loads, misuse, or degradation of materials providing load-bearing. Safety factors are often calculated using detailed analysis and must be determined to a reasonable accuracy because comprehensive material testing is impractical on many projects.

The specific design and minimum required Factor of Safety criteria for the proposed large-scale waste materials storage facilities and the methodology applied to develop the designs of the proposed facilities in order to meet these criteria are discussed for each facility in the respective sections below.

The potential effects of hypothetical failure scenarios have not been assessed in this SDEIS, as the risk of failure is mitigated through application of design and safety requirements including adaptive management procedures.

5.2.14.2 NorthMet Project Proposed Action

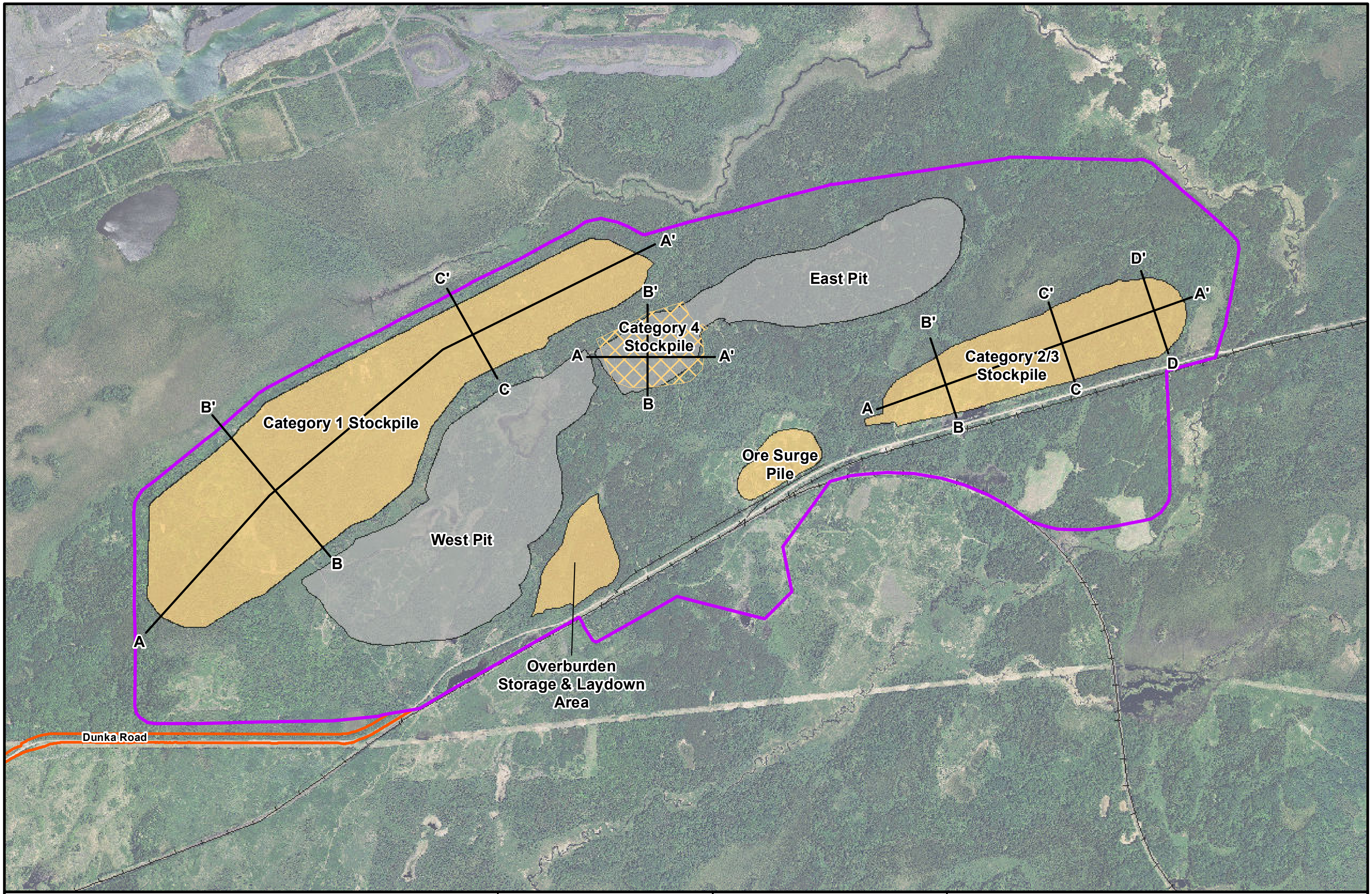
5.2.14.2.1 Waste Rock Stockpiles

The proposed large scale waste material storage facilities at the Mine Site are (Chapter 3.0):

- a permanent waste rock stockpile for Category 1 waste rock, and
- temporary stockpiles for Category 4 waste rock, combined Category 2/3 waste rock, and an Ore Surge Pile.

PolyMet expects that the NorthMet Project Proposed Action would produce approximately 308 million tons of waste rock over the life of mine. Waste rock would be categorized and managed based on its potential to oxidize. The least reactive Category 1 waste rock would be placed into a permanent stockpile, while Category 2/3 waste rock and Category 4 waste rock would be stored in temporary stockpiles before being backfilled into the East Pit after year 11. The location of the stockpiles is shown in Figure 5.2.14-1. The total weight of waste rock stored in a permanent stockpile (Category 1 Stockpile) would be approximately 168 million tons (Section 3.2.2.1).

The data inputs, evaluation methodology, results, and design and operating requirements for the stockpiles were reported in Geotechnical Data Package Volume 3 Version 2 (PolyMet 2012b) and reviewed by the Co-lead Agencies.



Mine Site
Active Stockpile
Category 4 Stockpile
Mine Pit
Stockpile Cross-Section
Transportation and Utility Corridor
Existing Railroad

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

0 500 1,000 2,000 3,000 Feet

Figure 5.2.14-1
Mine Site Plan - Year 11
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

DRAFT SUBJECT TO REVISION

April 2013

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Design Criteria

Waste rock stockpiles must be designed to comply with Minnesota Rule 6132.2400 (stockpile slopes are required to meet Minnesota Rule 6132.2400 Subp. 2. B. and stockpile foundations are required to meet Minnesota Rule 6132.2400 Subp. 2. A. (1)). These are design requirements that have been established to insure acceptable slope stability safety factors for global stability and acceptable foundation stability, the latter of which relates to the capability of the geomembrane liner system to withstand the strain anticipated due to differential settlement that may occur in the stockpile foundation materials.

The NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A) requires PolyMet to perform stockpile subgrade settlement analysis to predict magnitude of deformation and resulting strain in the stockpile liners for comparison to allowable strain in the liner system. Allowable strains are material-specific and would be determined from manufacturers specifications for the materials selected for the stockpile liners.

Methodology

In order to demonstrate that the design of the stockpiles would meet the geotechnical requirements, PolyMet completed the following:

- collected existing conditions data needed to support foundation design (refer to Section 4.2.14);
- configured stockpile slopes to meet or exceed the minimum dimensional requirements established by *Minnesota Rules* 6132.2400;
- conducted a stockpile subgrade settlement analysis to predict the magnitude of deformation and resulting strain in the stockpile liners for comparison to allowable strain in the liner system;
- completed slope stability analyses using RocScience’s limit equilibrium program SLIDE; and
- developed the stockpile design and operating requirements necessary to maintain required slope stability safety factors and liner performance requirements.

Design

Various design specifications have been established and used for the stockpile analysis (PolyMet 2012b). The following is a summary of the design characteristics applied and considered in geotechnical evaluation.

The Category 1 Stockpile has been designed as follows:

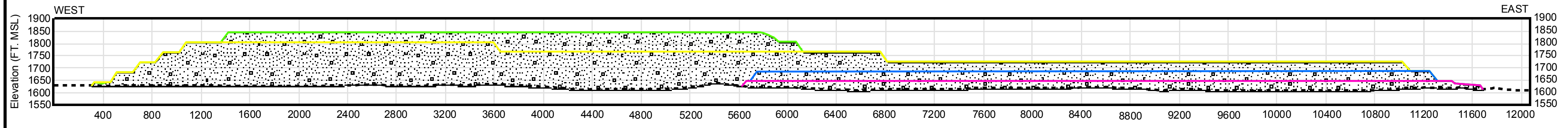
- to be permanent;
- to have a maximum lift height of 40 ft, bench width of 30 ft, initial slopes between benches at the angle of repose of the waste rock and final reclamation slopes between benches of 2.5 (horizontal) to 1 (vertical), as specified in *Minnesota Rule* 6132.2400;
- progressive reclamation including grading (3.75(H):1(V) regraded interbench slopes), contouring, and covering during operation; and
- a permanent LLDPE geomembrane surface cover (at closure).

The Category 2/3 Stockpile, Category 4 Stockpile, and the Ore Surge Pile have been designed for the following:

- to be temporary,
- to be lined with a LLDPE geomembrane,
- to have an underdrain system (minimum grade of 0.5 percent), as required, and
- to have an overliner drainage system (minimum grade of 0.5 percent).

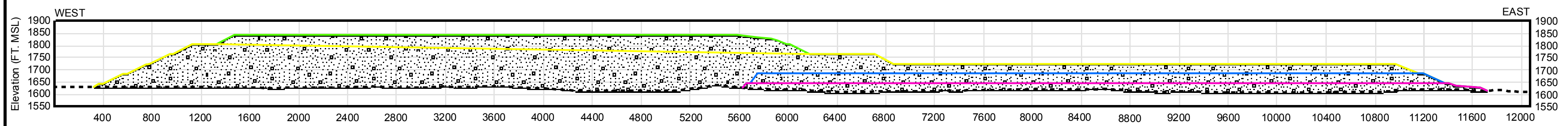
Cross sections of the proposed stockpiles are shown in Figure 5.2.14-2 and Figure 5.2.14-3.

The stability model (SLIDE) assumed a geomembrane liner interface friction angle (i.e., the strength that the geomembrane possesses for resisting sliding against the adjacent earthen material) of 15.7 degrees or greater. Further geotechnical investigations of the existing conditions are required to verify the actual liner interface frictional values, as well as the strength parameters for the foundation and stockpile materials prior to construction. To mitigate associated uncertainty, PolyMet commits to remove all unsuitable foundation soils from beneath lined stockpiles and replace them (where required) with structural fill to meet strength and grade requirements (PolyMet 2012o). PolyMet also commits to undertaking further geotechnical investigations prior to the construction of the stockpiles to define the foundation management needs.



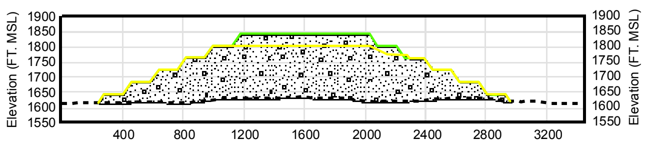
A: Operational Configuration Section

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



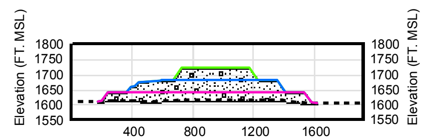
A: Reclamation Configuration Section - Interbench Slopes 3.75H:1V

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



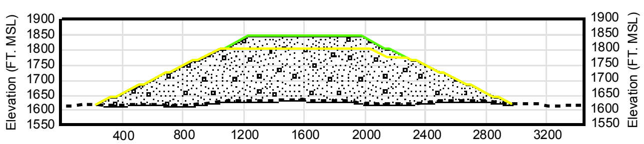
B: Operational Configuration - West Section

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



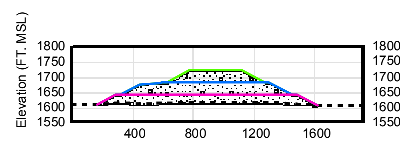
B: Operational Configuration - East Section

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



B: Reclamation Configuration - West Section, Interbench Slopes 3.75H:1V

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



B: Reclamation Configuration - East Section, Interbench Slopes 3.75H:1V

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration

Year 1
Year 2
Year 11
Ultimate Extent
Existing Ground Surface

US Army Corps of Engineers
St. Paul District

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Figure 5.2.14-2
Cross Sections of the Proposed Category 1 Stockpile
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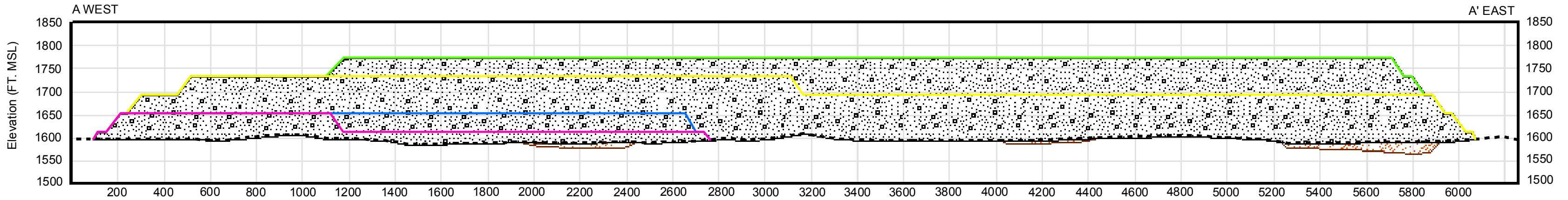
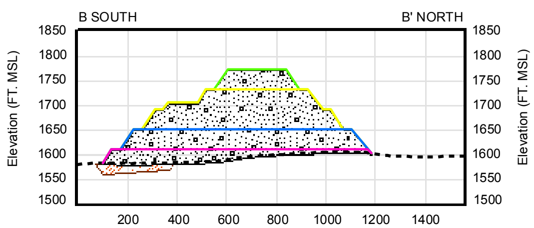


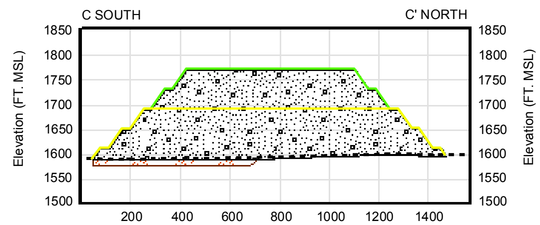
A: Category 2/3 Stockpile

2:1 Vertical Exaggeration



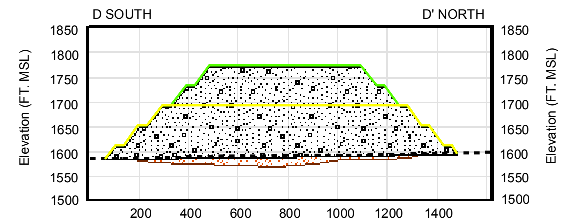
B: Category 2/3 Stockpile

2:1 Vertical Exaggeration



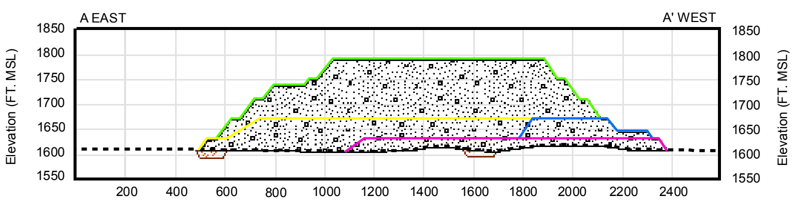
C: Category 2/3 Stockpile

2:1 Vertical Exaggeration



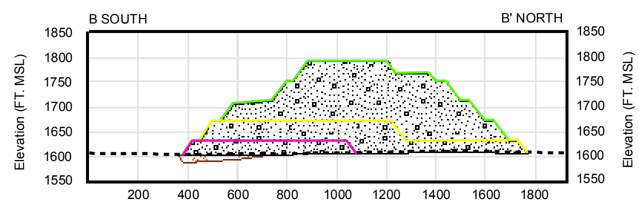
D: Category 2/3 Stockpile

2:1 Vertical Exaggeration



A: Category 4 Stockpile

2:1 Vertical Exaggeration



B: Category 4 Stockpile

2:1 Vertical Exaggeration

- Year 1
- Year 2
- Year 11
- Ultimate Extent
- Existing Ground Surface
- Unsuitable Soil Excavation Surface

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Figure 5.2.14-3

Cross Sections of the Proposed Category 2/3 and 4 Stockpiles at Maximum Size

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Modeling Results

The results reported in Geotechnical Data Package Volume 3 Version 2 indicate that the proposed design of the stockpiles would meet all required Factors of Safety (PolyMet 2012b). The geotechnical evaluation is summarized below.

Stability

PolyMet undertook a stability analysis of the design cross sections developed to represent the following typical conditions at different phases of stockpile development:

- Temporary Category 2/3 Stockpile, Category 4 Stockpile, and Ore Surge Pile
    1. Initial operational configuration (single lift of waste rock placed in two stages).
    2. Operational configuration at proposed final buildout (excludes the Ore Surge Pile, which would fluctuate).
- Permanent Category 1 Stockpile
    1. Initial operational configuration (a single lift of waste rock with a maximum height of 40 ft placed at the angle of repose).
    2. Operational configuration at proposed final buildout prior to reclamation (assume four lifts of waste rock).
    3. Reclaimed configuration, interbench slopes regraded to 2.5(H):1(V).
    4. Reclaimed configuration, interbench slopes regraded to 3.0(H):1(V).
    5. Reclaimed configuration, interbench slopes regraded to 3.75(H):1(V).
    6. Assuming a liner interface (i.e., overliner material/LLDPE geomembrane liner/soil liner) friction angle of 15.7 degrees or greater

Results indicated that all design sections met the minimum required Factors of Safety.

Estimated liner strains resulting from foundation settlement are less than 1 percent; well below the 30 percent maximum strain allowed in the LLDPE geomembrane proposed for the geomembrane barrier layer component of the basal liner system for the Category 2/3 Stockpile, Category 4 Stockpile, and the Ore Surge Pile.

Proposed Monitoring, Maintenance, and Mitigation

A Rock and Overburden Management Plan (PolyMet 2012s) has been prepared by PolyMet that includes a description of the operating plans, monitoring procedures, and adaptive management approaches for the stockpiles.

The stockpile quantities would be monitored throughout the life of the mine and the stockpile heights and footprints would be monitored to verify that they are constructed as designed. Monitoring and maintenance of the Category 1 Stockpile would also continue through the post-closure period until the MDNR determines that the cover is stable. An annual compliance report would be developed each year for submittal to the MDNR to comply with the Permit to Mine requirements.

Information gained through ongoing monitoring would also be used to advise adaptive waste management requirements should the capacity of the Category 2/3 Stockpile, the Category 4 Stockpile, and/or the East Pit be insufficient for the mined volume of Category 2/3 and Category 4 waste rock generated by mining. Adaptive waste rock management could include expansion of the waste rock stockpiles and/or disposal of some of the waste rock or saturated overburden in the West Pit in areas where mining has ceased.

Each year a plan comparison would be completed, as required for the Permit to Mine, to keep the Rock and Overburden Management Plan (PolyMet 2012s) current and to track changes in the mine plan, rock type schedule, and characterization of the material. Modifications to the Rock and Overburden Management Plan based on changes to the material characterization would be completed, as necessary.

5.2.14.2.2 Tailings Basin

Tailings from the beneficiation process would be disposed of in a Tailings Basin, constructed on top of Cell 1E and Cell 2E of the existing LTVSMC Tailings Basin. Figure 5.2.14-3 depicts the Tailings Basin at its proposed final evaluation (year 20).

The data inputs, modeling methodology, results, and design and operating requirements for the Tailings Basin were reported in Geotechnical Data Package Volume 1 Version 4 (PolyMet 2013n) and Flotation Tailings Management Plan (PolyMet 2013m), which were reviewed by the Co-lead Agencies. The information provided in the data package informs the permitting process and is summarized below.

Design Criteria

In Minnesota, dams must be constructed in accordance with applicable requirements of *Minnesota Rules* 6115.0300 through 6115.0520. In addition, under the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A), the Co-lead Agencies require that the critical cross section of the Tailings Basin is demonstrated to meet or exceed the following minimum Factors of Safety as required for various construction and loading scenarios:

- Factor of Safety greater than or equal to 1.5 for effective stress conditions using parameters that reflect drained shearing conditions.
- Factor of Safety greater than or equal to 1.3 for undrained strength conditions for soils that are not prone to static liquefaction using undrained shearing conditions.
- liquefaction analysis of liquefiable materials in undrained shearing conditions including:
  - static liquefaction triggering analysis (i.e., induced by over steepening of slopes or pond bounce) Factor of Safety greater than or equal to 1.1;
  - seismic liquefaction triggering analysis (i.e., induced by seismic event) Factor of Safety greater than or equal to 1.2 (or if the results of deformation modeling is accepted by the Co-lead Agencies if factor of safety is >1.0); and
  - liquefied scenario (assumes all saturated contractive materials have liquefied) Factor of Safety) greater than or equal to 1.10.

These minimum Factors of Safety were selected with consideration for:

- the proposed construction of the Tailings Basin on top of the existing LTVSMC Tailings Basin and the known geotechnical conditions and material characteristics of the existing facility;
- the expected characteristics of the NorthMet Project tailings and construction materials and methods, including long-term wet closure; and
- similar industry standards and other large tailings dams in Minnesota.

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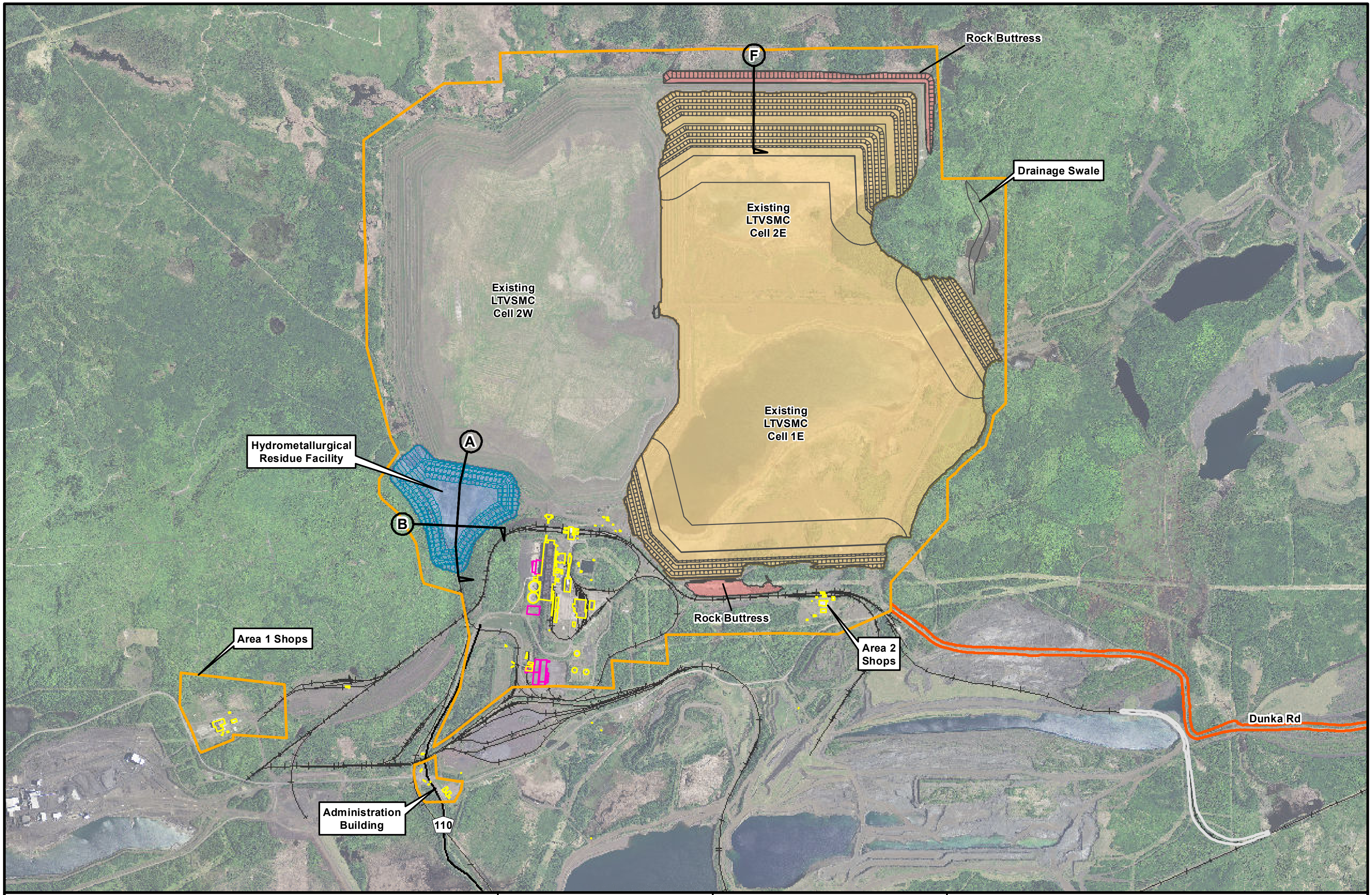

Plant Site
Tailings Basin
Proposed Buildings
Existing Building
Hydrometallurgical Residue Facility
Rock Buttress
Transportation and Utility Corridor
Railroad Corridor
Cross-Section
Existing Railroad

US Army Corps of Engineers
St. Paul District

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N W E S

0 1,000 2,000 4,000 Feet

Figure 5.2.14-4
Proposed Plant Site Layout
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Methodology

In order to demonstrate that the design of the Tailings Basin would meet the respective geotechnical requirements, PolyMet, in accordance with the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A)):

1. Gathered conditions data (i.e., existing basin topography, stratigraphy, soil and tailings strength and hydraulic characteristics (Section 4.2.14), characteristics of NorthMet tailings based on those produced during the pilot-plant processing, and other data as needed to support geotechnical modeling and Tailings Basin design).
2. Developed Tailings Basin cross sections (i.e., geometry and stratigraphy for existing and planned conditions) for the Tailings Basin for seepage and stability modeling.
3. Developed seepage and stability models using Geo-Slope International, Inc. modeling software (i.e., SLOPE/W, SEEP/W and SIGMA/W as necessary) for various construction and loading scenarios (such as various dam crest and pond surface elevations during construction and closure).
4. Established the geotechnical design data for model input including identification of hydraulic and strength parameters and the triggering potential for static and seismic events of the various tailings material types.
5. Performed modeling and results interpretation.
6. Refined the design and operating requirements necessary until modeling showed that the required slope stability Factors of Safety are achieved for the critical slope cross section.

Design

Various design specifications have been established and used for Tailings Basin geotechnical analysis (PolyMet 2013n). The following is a summary of the design characteristics applied and considered in modeling.

The Tailings Basin would be constructed using the upstream method, whereby NorthMet dam embankments would be built (of existing and new tailings material) on top of the existing LTVSMC tailings embankment. NorthMet bulk tailings would be discharged into the new basin by perimeter spigots and a pond barge pump. New dam embankments (using LTVSMC Bulk tailings) would be raised in stages on top of the existing LTVSMC tailings impoundment, and the new tailings are deposited upstream of the dam into the basin from spigots at the dam's edge. Tailings would also be discharged subaqueously in the basin via a barge.

The Tailings Basin incorporates construction of new dam embankments over the existing LTVSMC Tailings Basin Cells 1E and 2E. The design process is an iterative approach whereby various combinations of stabilization factors including slope angle, lift set-back and thickness, intermediate slope bench width, drainage layers beneath the proposed NorthMet tailings, and supporting rock buttresses were modeled to identify a design that would achieve the following:

- provide safe permanent storage of tailings generated over the proposed 20-year operating life of the NorthMet Project Proposed Action and maintain stability post-closure;

- efficiently and effectively recover process water from the surface of the Tailings Basin during operation, and contains all groundwater and surface water seepage during operation and long term (refer to Section 4.2.2 for more information on water management);
- accommodate the planned partially wet cover system at closure; and
- meet project regulatory requirements (including Factors of Safety).

As shown in Figure 5.2.14-5, the proposed design consists of eight lifts with a proposed final crest elevation (selected on the basis of tailings storage capacity requirements) modeled as 1,732 ft amsl. This would be an additional 150 ft on top of the existing LTVSMC Tailings Basin Cell 2E. This proposed elevation is similar to the elevation of the existing north dam of Cell 2W, which is at a proposed final elevation of 1,735 ft amsl. A schematic cross section of the Tailings Basin is shown in Section 3.2.2.3.

Before placement of tailings, coarse tailings sourced from the existing LTVSMC Tailings Basin would be used to construct a drainage layer to maintain a lowered phreatic surface within the new dam. A lower phreatic surface would help to prevent saturation (and weakening) of the dam embankments. Additional modeling would be conducted to ascertain if this drainage layer needs to be continuous along the length of the dam, or if narrow segments of foundation material would prove to be as effective. Rock buttresses would be placed at the northern toe of the existing Cell 2E starter dam, and at the south end of Cell 1E near the railroad fill to provide resistance to the driving forces created by the dam raises. Buttress material would likely consist of waste rock sourced from a nearby taconite mining stockpile.

The proposed dams would be constructed from mechanically placed and compacted “bulk tailings” taken from the existing LTVSMC Tailings Basin (supplemented with material sourced off-site if required) as needed to produce the desired dam lift height and geometry. LTVSMC “bulk tailings” are currently defined as a mixture of tailings that predominantly consists of LTVSMC coarse tailings with occasional inclusions of LTVSMC fine tailings and a small amount of slimes. The exterior face of the dams would be augmented with a bentonite layer to limit oxygen and rain water infiltration into the Tailings Basin.

The combined lifts would have an overall slope of 4.5H:1V, including setbacks, on the outside of the basin, but individual lifts would have a much steeper slope. Each lift would be 20 ft high, with the exception of the final lift, Lift 8, which would be 10 ft in height. There is a 60-ft bench on top of each lift, with an additionally 200-ft setback on top of Lift 4, and a 625-ft beach extending from the interior crest of dam to the edge of the Tailings Basin pond.

As dams are constructed, exterior slopes would be covered with bentonite and vegetated. Upon reaching the final proposed dam elevation (after 20 years of operation), the Tailings Basin would be closed in accordance with *Minnesota Rules* 6132.3200 and would also include the following:

- bentonite augmentation of the pond area bottom to reduce infiltration to a sufficient degree to maintain desired pond water elevations at closure;
- bentonite augmentation of the exposed embankments and beach areas; and
- establishment of wetland vegetation in transition areas between the beach and pond area.

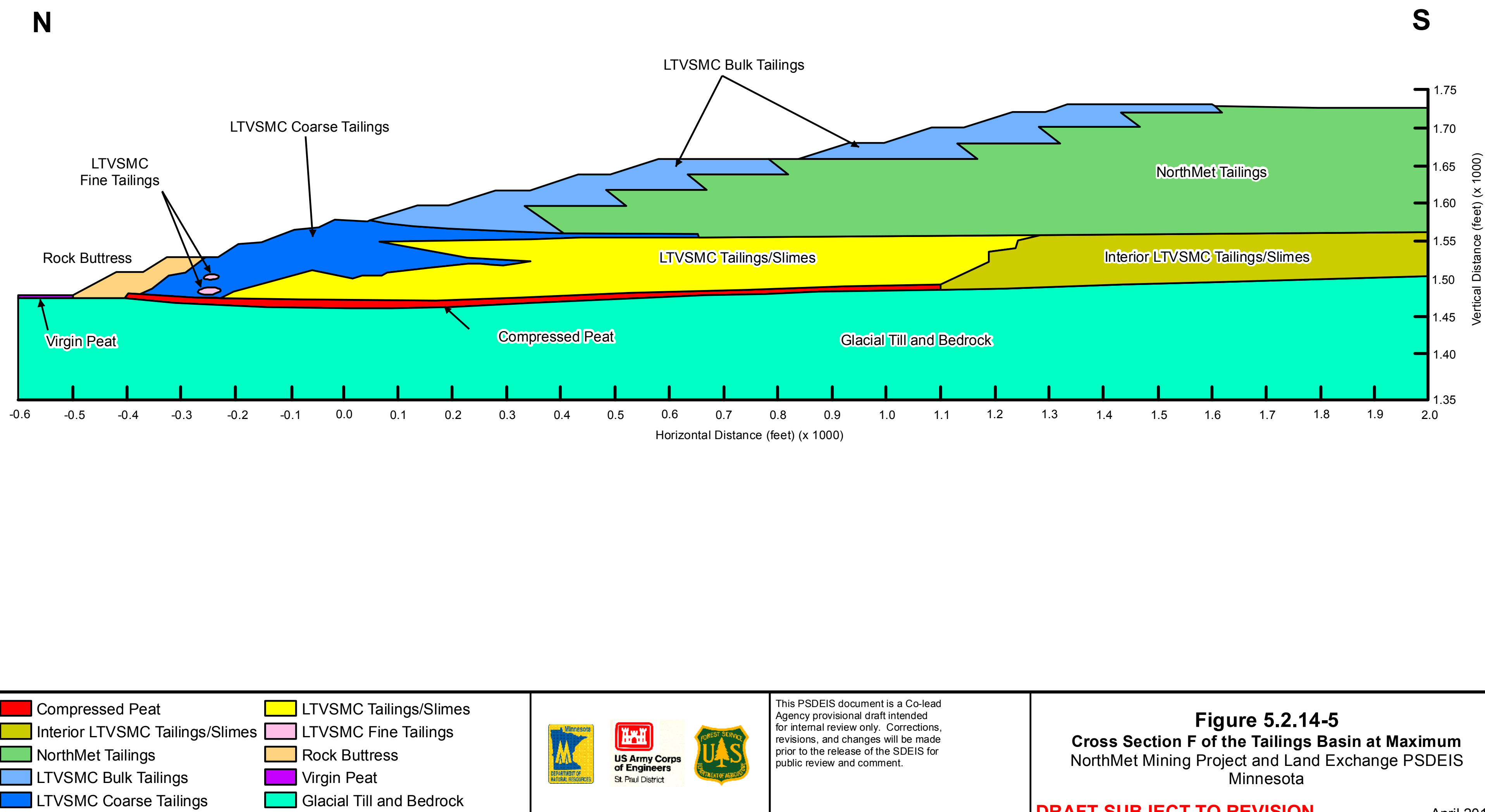

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Figure 5.2.14-5

Cross Section F of the Tailings Basin at Maximum

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Identification of the Critical Cross Section

Geotechnical conditions along the length of existing LTVSMC Tailings Basin dams have varying layers of coarse, fine, and slime tailings. Cross Section F, which intersects the northern dam of Cell 2E, as shown in Figure 5.2.14-4, was selected to represent the critical cross section for stability analysis purposes as it is the maximum section and some layers of the weaker fine and slime tailings extrude close to the dam embankment, and the dam embankment is underlain by peat. Material types identified from borings in the existing LTVSMC Tailings Basin along Cross Section F are shown in Figure 4.2.14-3. Figure 5.2.14-5 shows the proposed design of the NorthMet Project Proposed Action Tailings Basin along Cross Section F at its full extent.

Cross Section F was analyzed in a sequential manner consisting of the development of the dam cross section stratigraphy for analyses, application of the material strength and permeability characteristics, and modeling of seepage conditions at the dam cross section, followed by stability analyses.

Once the preliminary Cross Section F configuration was determined, Cross Section F was evaluated with the Tailings Basin at the proposed final crest height to determine whether liquefaction would be triggered in the contractive materials, based on certain triggers prescribed in the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A)).

Modeling Results

The results reported in Geotechnical Data Package Volume 1 Version 4 indicate that the proposed design of the Tailings Basin would meet all respective Factors of Safety as required (PolyMet 2013n). The modeling undertaken and results obtained are summarized below. Subsequent to Geotechnical Data Package Volume 1 Version 4, PolyMet evaluated the effect that the Tailings Basin groundwater containment system. Results indicated that the groundwater containment system would not have a material effect on the stability of the Tailings Basin or the Factor of Safety results determined in Geotechnical Data Package Volume 1 Version 4 and provided below (Barr 2013l.

These results would be further verified before the completion of permitting.

Slope Stability

The predicted Factor of Safety values for Cross Section F at various stages of development of the Tailings Basin are summarized in Table 5.2.14-1. All slope stability factors are designed to meet the factors of safety required by the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A).

Table 5.2.14-1 Stability Modeling Results for the Tailings Basin

Target Factor of Safety Value:		1.3	1.5
Case	**Slip Surface**	**Undrained Strength Stability Analysis ($USSA_{yield}$) Factor of Safety**	**Effective Stress Stability Analysis (ESSA) Factor of Safety**
Lift 2	Grid and Radius, Optimized[1] – Circular[2]	1.94	3.66
	Grid and Radius, Optimized[1] – Wedge[3]	1.89	2.32
Lift 4	Grid and Radius, Optimized[1] – Circular[2]	1.78	3.65
	Grid and Radius, Optimized[1] – Wedge[3]	1.75	2.26
Lift 6	Grid and Radius, Optimized[1] – Circular[2]	1.82	3.64
	Grid and Radius, Optimized[1] – Wedge[3]	1.81	3.78
Lift 8 – Proposed Final Crest Height with Normal Pond	Grid and Radius, Optimized[1] – Circular[2]	1.82	3.70
	Grid and Radius, Optimized[1] – Wedge[3]	1.83	3.80
Lift 8 – Proposed Final Crest Height with Maximum Pond[4]	Grid and Radius, Optimized[1] – Circular[2]	1.81	3.57
	Grid and Radius, Optimized[1] – Wedge[3]	1.81	3.80
Long-term Closure Conditions	Grid and Radius, Optimized[1]	NA	3.71
	Grid and Radius, Optimized[1] – Wedge[3]	NA	3.65

Source: PolyMet 2013n.

[1] Assumes that failure of a soil mass could occur in any manner.
[2] Assumes failure of a soil mass would occur as though it is rotating within a larger mass.
[3] Assumes failure of a soil mass would occur as a large, monolithic block (wedge) sliding relative to the surrounding soil mass.
[4] Probable Maximum Precipitation event whereby the pond level suddenly raised 4 ft in elevation, remained high long enough for steady-state conditions to apply.

<u>*Liquefaction*</u>

The potential for liquefaction, where a triggering event changes the stress state of the material such that it loses a significant amount of its strength, was assessed under different scenarios, including rapid loading and construction, ineffective underdrain resulting in increased saturation, and erosion events. Results shown in Table 5.2.14-2 indicate that the design meets the minimum Factor of Safety.

A scenario for liquefaction was evaluated whereby all contractive, saturated soils were modeled with their liquefied strengths. Table 5.2.14.3 and Table 5.2.14.4 show that, though unlikely, if triggering were to occur at the end of operations, or 20, 200, or 2,000 years after operations, the design meets the minimum Factors of Safety deemed acceptable by the Co-lead Agencies.

Potential for seismic activity was also analyses and assessed. Results indicated that there is a very low likelihood of liquefaction as a result of seismic events.

Table 5.2.14-2 Results of Liquefaction Triggering Analyses for Tailings Basin

Target Factor of Safety Value:	**1.3**	
Liquefaction Triggering Scenario	**Factor of Safety (overall)**	**Average Factor of Safety (triggering)**
Baseline (design conditions)	2.27	2.27
Plugged drain, Lift 8	2.27	2.27
Rapid loading – fast construction of Lift 1	1.93	2.09
Retrogressive erosion – local erosion/pipe scour	2.15	2.15
Plugged drain, Lift 1	1.85	1.85

Table 5.2.14-3 Modeled Factors of Safety for Worst-case Flow Liquefaction Conditions

Target Factor of Safety Value:		**1.1**
Case	**Slip Surface**	**Factor of Safety (overall)**
All Saturated Contractive Materials Liquefied to Undrained Strength Stability ($USSR_{liq}$)	Grid and Radius, Optimized[1] – Circular[2]	1.25
	Grid and Radius, Optimized[1] – Wedge[3]	1.11

Source: PolyMet 2013n

[1] Assumes that failure of a soil mass could occur in any manner.
[2] Assumes failure of a soil mass would occur as though it is rotating within a larger mass.
[3] Assumes failure of a soil mass would occur as a large, monolithic block (wedge) sliding relative to the surrounding soil mass.

Table 5.2.14-4 Modeled Factors of Safety for Fully Liquefied Long-term Conditions for the Tailings Basin

Target Factor of Safety Value:		**1.1**
Case		**Effective Stress Stability Analysis**
Long-term Fully Liquefied Conditions	20 years after end of operations	1.13
	200 years after end of operations	1.20
	2,000 years after end of operations	1.24

Source: PolyMet 2013n

Long-Term Closure Stability Conditions

While it is normally preferable from a stability perspective to allow tailings facilities to drain and dry out following closure, the NorthMet Project Proposed Action involves maintaining a pond on top of the Tailings Basin for water quality management purposes.

The Tailings Basin would be covered with a bentonite-amended surface on the exterior face of the NorthMet Project dam lifts (amended during construction). After the Tailings Basin has been filled to its maximum height, the dam would be prepared for reclamation by amending the 625-ft beach of tailings and the bottom of the pond with bentonite.

Modeling was undertaken to predict the long-term stability of the Tailings Basin. As shown in Table 5.2.14-1 and Table 5.2.14-4, the long-term closure slope stability Factors of Safety are above the minimum value required under the Work Plan.

Proposed Monitoring

Geotechnical investigations would be performed on the Tailings Basin during construction and operations to confirm that the construction and performance of the dam meet design criteria. This approach is standard for large earthen structures that are developed incrementally over long periods of time.

A Flotation Tailings Management Plan (PolyMet 2013m) has been prepared by PolyMet that includes a description of the operating plans, monitoring procedures, and adaptive management approaches for the Tailings Basin. Monitoring activities include construction material sampling, geotechnical instrumentation, geotechnical investigations, and systematic dam safety inspections.

Existing and proposed geotechnical instrumentation would measure actual tailings dam performance by monitoring stability, seepage, and deformation. Monitoring instrumentation relevant to geotechnical stability would include:

- **piezometers** to facilitate monitoring of the phreatic surface within the Tailings Basin and perimeter dams (the phreatic surface has a significant effect on slope stability), which would be compared to modeled phreatic surface;
- **inclinometers** to facilitate monitoring of the movement of the Tailings Basin dams, which would be compared to the modeled movement; and
- **survey monitoring points** to facilitate the monitoring of horizontal and vertical deformation (including settlement) of the Tailings Basin dams.

Geotechnical investigations and systematic dam safety inspections would include:

- staff observation of the condition of the dam and the reporting of any conditions that indicate a departure from the design specifications.
- weekly/daily routine dam inspections by staff to observe the conditions and performance of the Tailings Basin dams and associated facilities so that any changes to dam conditions could be identified and promptly addressed. These would supplement more detailed Dam Safety Inspections (below).
- regulator Dam Safety Inspections to evaluate, on a regular basis, the current and past performance of the Tailings Basin dams and to observe potential deficiencies in their condition, performance, and/or operation.
- semi-annual Dam Safety Inspections undertaken by the Design Engineer (an independent consultant retained specifically for dam safety expertise and a Minnesota-registered engineer).
- inspection after unusual events to monitor and report observations.
- routine Dam Safety Reviews every 5 years by a qualified geotechnical engineer registered in the State of Minnesota. The review would ascertain that the dam has an adequate margin of safety, based on the current Dam Safety Permit, current engineering practice, and updated operations and design input data. A Dam Safety Review may also be carried out to address a specific problem.

Annual reports on the conditions of the Tailings Basin are required under the MDNR Dam Safety Permit and Permit to Mine. Monitoring and maintenance would continue post closure in accordance with permit requirements.

Proposed Maintenance and Mitigation

Typical maintenance of the facility would include repairing eroded surfaces and repair and replacement of damaged monitoring and operational infrastructure. The majority of the non-mechanical maintenance work at the Tailings Basin would be carried out on an as-required basis, rather than on a scheduled basis because it is driven by weather events rather than hours of operation.

Where monitoring or model updates indicate that the Factor of Safety for the Tailings Basin no longer meets design criteria, appropriate modifications to the Tailings Basin would be considered, modeled, and, if necessary, undertaken. Modifications could include but are not limited to: modification of bench widths between lifts of the dam, modification of lift heights, and modification of slope angles. Other modifications could include increasing the size of the rock buttress, improving the performance of underdrains, increasing mid-slope setbacks, and modifying materials used for dam construction to achieve higher strengths.

A Contingency Action Plan has been prepared as part of the Flotation Tailings Management Plan (PolyMet 2013m). The plan provides guidance to on-site personnel and emergency responders in the case of unplanned occurrences at the Tailings Basin. The plan defines three levels of hazardous and emergency conditions response:

1. Level 1 is defined as unusual conditions that do not warrant an emergency response but require prompt investigation and resolution.
2. Level 2 is defined as conditions that represent a potential emergency, if sustained or allowed to progress, but no emergency situation is imminent. The first action in the event of a Level 2 emergency condition is to discuss and define a response plan.
3. Level 3 is defined by either imminent failure of the Tailings Basin or a significant component thereof. The first actions in the event of any Level 3 condition are to check all persons who could potentially be affected are safe, initiate the appropriate chain of communications, and immediately undertake appropriate response actions.

5.2.14.2.3 Hydrometallurgical Residue Facility

As shown in Figure 5.2.14-4, hydrometallurgical residue would be disposed of a new Hydrometallurgical Residue Facility that would be located at the site of the existing LTVSMC Emergency Basin, adjacent to the southern extent of existing LTVSMC Tailings Basin Cell 2W.

The data inputs, modeling methodology, results, and design and operating requirements for the Hydrometallurgical Residue Facility were reported in Geotechnical Data Package Volume 2 Version 3 (PolyMet 2012a) and reviewed by the Co-lead Agencies. The information provided in the data package informs the permitting process and is summarized below.

Design Criteria

The design of the Hydrometallurgical Residue Facility must meet the applicable requirements of *Minnesota Rules* 6115.0300 through 6115.0520 and the requirements of the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A)) which include the following:

- the ability of the most sensitive slope cross section to meet a global slope stability factor of 1.5;
- the ability of the composite liner system to comply with infinite slope stability safety factor of 1.5, and
- the capability of the composite liner system to withstand the longitudinal strain anticipated due to differential settlement that may occur in the facility foundation materials.

Methodology

PolyMet took the steps listed below in order to demonstrate that the design of the Hydrometallurgical Residue Facility would meet the respective geotechnical requirements and would be in accordance with the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A)):

1. Gathered existing conditions data (i.e., facility foundation material stratigraphy and strength data, hydrogeological data, characteristics of NorthMet Project Proposed Action residues based on those produced during the pilot-plant processing, and other data as needed to support geotechnical modeling of the Hydrometallurgical Residue Facility) (Section 4.2.14).
2. Developed residue facility layout and cross sections (i.e., geometry and stratigraphy for existing and planned conditions) for proposed residue facility stability and deformation modeling.
3. Developed seepage and stability models using Geo-Slope International, Inc. modeling software (i.e., SLOPE/W, SEEP/W and SIGMA/W as necessary) for maximum facility dam height with minimum and maximum pond elevation, and post-closure – cover effective with minimum pond elevation the maximum.
4. Established the geotechnical design data for model input including identification of strength parameters and the triggering potential for static and seismic events.
5. Ran the models to determine Factors of Safety, and the potential for slope failure and deformation of the foundation and liner.
6. Refined the design and operating requirements necessary to maintain required slope stability safety factors and deformation requirements for the critical slope cross section.

Design

Various design specifications have been established and used for the Hydrometallurgical Residue Facility geotechnical analysis (PolyMet 2012a). The following is a summary of the design characteristics applied and considered in modeling.

The Hydrometallurgical Residue Facility has been designed as a single cell structure with a design capacity of 6,400,000 cubic yards to be located on top of the existing LTVSMC Emergency Basin. The perimeter would have an irregular shape consisting of the north dam, natural high ground, and new dams (see Figure 5.2.14-4)

The maximum height of the proposed dams is approximately 85 ft with a crest elevation of 1,650 ft amsl and an additional 3-ft minimum freeboard (14-ft maximum freeboard at a residue surface slope of 0.5 percent). The exterior, downstream face of the dam would be constructed at a slope of 4 horizontal to 1 vertical (4:1).The interior of the Hydrometallurgical Residue Facility would be sloped at 4H:1V and 30-ft horizontal benches would be placed at elevations of 1,600 and 1,630 ft amsl.

Prior to construction of the dams, PolyMet would perform the following tasks:

1. install a granular drainage layer at the existing LTVSMC Emergency Basin, as needed to facilitate wick drain installation and operation;
2. install wick drains; and
3. place, monitor, and remove a surcharge load fill in the existing LTVSMC Emergency Basin to pre-consolidate existing material, thereby reducing future anticipated settlements to mitigate the potential future strains.

A geosynthetic liner system would be installed with the following components, listed in order from top to bottom:

1. upper geomembrane;
2. geocomposite (geonet) (for leakage collection and recovery);
3. lower geomembrane; and
4. geosynthetic clay liner.

The dams would be constructed using downstream construction methods that involve constructing a smaller starter dam first and then raising the dam upward and outward over the downstream shell of the damn as additional capacity is needed. Construction material would be sourced from natural soil and quarried bedrock between the high ground and south dam. Some LTVSMC coarse tailings may also be utilized for dam construction. While the material is placed, it would be compacted to the design density.

Identification of the Critical Cross Section

Cross Section A, depicted in Figure 5.2.14-4, has been identified as the critical cross section. It approximates the base of a former ravine, beginning south of the future south dam and terminating near the crest of the Hydrometallurgical Residue Facility north dam. It is considered to be the most critical cross section, as it incorporates the thickest sections of LTVSMC slimes. Fine tailings and slimes in the Emergency Basin are the thickest at approximately 50 ft at Node A located 280 ft away from the toe of the south dam. A cross section of the Hydrometallurgical Residue Facility at its maximum extent along cross sections A and B is shown in Figure 5.2.14-6.

The global slope stability discussed below was assessed along Cross Section A.

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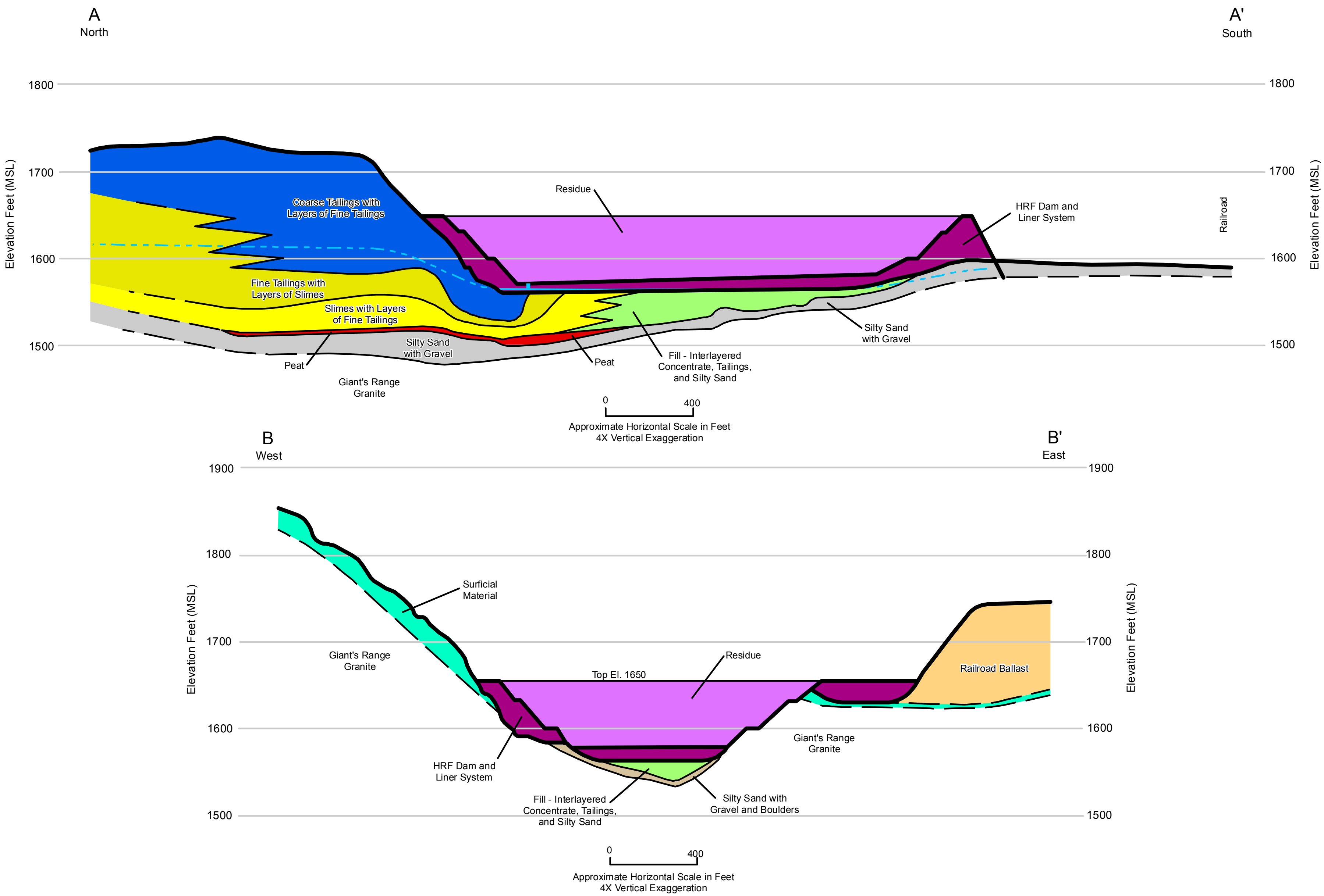

Coarse Tailings with Layers of Fine Tailings

Fill - Interlayered Concentrate, Tailings, and Silty Sand

Fine Tailings with Layers of Slimes

Slimes with Layers of Fine Tailings

Peat

Railroad Ballast

Residue

Silty Sand with Gravel

Silty Sand with Gravel and Boulders

HRF Dam and Liner System

Surficial Material

US Army Corps of Engineers
St. Paul District

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Figure 5.2.14-6

Cross Sections A and B of the Hydrometallurgical Residue Facility at Year 20

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Modeling Results

The results reported in Geotechnical Data Package Volume 2 Version 3 indicate that the proposed design of the Hydrometallurgical Residue Facility would meet all respective factors of safety as required (PolyMet 2012a). The modeling undertaken and results are summarized below.

Stress Deformation and Strain in the Liner System

A surcharge load would be placed on the existing LTVSMC Emergency Basin to consolidate the existing material before construction of the Hydrometallurgical Residue Facility. Wick drains would be used to help accelerate the consolidation time. Some portion of this load would be removed before construction, and the remaining material would be graded to provide a suitable foundation material for the facility. The material would rebound a small amount after the surcharge load is removed. The aggregate settlement at Node A is estimated to be 3.9 ft. The material at Node A is modeled to consolidate an additional 1.4 ft by the end of operations of the Hydrometallurgical Residue Facility.

Residue consolidation is modeled as beginning after the cessation of residue discharge to the Hydrometallurgical Residue Facility. Over time, the rate of consolidation would decrease with the greatest amount of consolidation occurring before pore-water pressure reaches hydrostatic equilibrium (approximately 10 years following closure). Total settlement in areas with the greatest depth of residue is estimated to be on the order of 9.6 ft. As the depth of residue decreases near the edge of the Hydrometallurgical Residue Facility, less settlement would occur. The resulting deformed surface of the Hydrometallurgical Residue Facility would be concave with the greatest deformation in areas of greatest residue thickness.

Strain in the Hydrometallurgical Residue Facility liner system would result from differential settlement between points along the liner. The maximum strain in the liner system is estimated to be 0.20 percent. This value is well within tolerable limits of most geosynthetics which range from 1 to 19 percent.

Global Slope Stability

Analysis of the new dams (i.e., those not supported by the existing LTVSMC Tailings Basin or natural topography) at their greatest height (at year 20) predicted the Factor of Safety for the ESSA to be 2.32, which is greater than the required minimum of 1.5. Because the angle of repose for the dam fill material (approximately 30 degrees) is greater than the proposed dam downstream slope angle (18 degrees), surficial slope failures are not expected.

Because the material in the constructed dams are proposed to be well compacted and because the Hydrometallurgical Residue Facility liner system would preclude leakage through the dams, undrained strength stability and Liquefaction Analyses were not applicable and not performed.

Infinite Slope Stability

The components of the double liner system are designed to act as hydraulic barriers to leakage; not as structural members of the dam system. Therefore, the liner layers must not be allowed to slide relative to one-another. Evaluation of this potential for sliding was performed using infinite slope stability analyses. The minimum infinite slope stability safety factor for all Hydrometallurgical Residue Facility liner system components is 1.5. On the basis of the interface friction angles used in the analysis, the design proposed for the Hydrometallurgical Residue Facility achieves a computed safety factor of 2.94.

The interior slope angle for the Hydrometallurgical Residue Facility and the geosynthetic materials of the liner that would directly contact the underlying soils used for dam construction must be selected to produce a stable liner system—a system that would not slide down-slope during operations. In addition, each successive layer of the liner system must have an adequate interface-friction angle with the adjacent layer to prevent down-slope movement of any layer of the liner system. Infinite slope stability for the liner system layer interface configurations currently expected are shown in Table 5.2.14-5. Computed factors of safety shown in Table 5.2.14-5 are based on commonly reported interface friction angles between the materials anticipated to be used for the Hydrometallurgical Residue Facility liner. Any variation from the anticipated material types warrants project-specific interface shear testing to confirm that the friction angles are equal to or greater than those used in this analysis.

Table 5.2.14-5 Infinite Slope Stability Analysis Results for the Hydrometallurgical Residue Facility

Interface Number	Material Types	Slope Angle, (deg)	Predicted friction Angle, (deg)	Minimum required Factor of Safety	Predicted Factor of Safety
4	Textured Geomembrane above Geocomposite Drainage Net	15.95	28	1.5	1.86
3	Geocomposite Drainage Net above Textured Geomembrane	15.95	28	1.5	1.86
2	Textured Geomembrane above Geosynthetic Clay Liner	15.95	28	1.5	1.86
1	Geosynthetic Clay Liner above Granular Soil	15.95	24	1.5	1.56

Proposed Monitoring, Maintenance, and Mitigation

A Hydrometallurgical Residue Management Plan (PolyMet 2012e) prepared by PolyMet includes a description of the operating plans, monitoring procedures, and adaptive management approaches for the Hydrometallurgical Residue Facility.

Monitoring and maintenance for the Hydrometallurgical Residue Facility would be similar to that discussed for the Tailings Basin above.

5.2.14.3 NorthMet Project No Action Alternative

Under the No Action Alternative, no waste rock stockpiles, or expanded Tailings Basin, or Hydrometallurgical Residue Facility would be created. The existing geotechnical conditions are discussed in Section 4.2.14. The existing LTVSMC Tailings Basin as discussed in Section 4.2.14 would remain at the site and monitoring and inspection would continue under the LTVSMC site closure plan and the MDNR Dam Safety regulations.

5.3 LAND EXCHANGE

5.3.1 Land Use

The Land Exchange Proposed Action represents a transfer of surface rights of 6,495.4 acres from the Superior National Forest to PolyMet for the purpose of mine development and operation. This action would remove those acres from Superior National Forest management and public access and use. The Land Exchange Proposed Action would also make these acres, which are part of the 1854 Ceded Territory, unavailable for use by the Bands. Given the existing lack of permitted public access and actual use of the federal lands, as well as historic use of this area for mineral exploration (see Section 4.2.11), the Land Exchange Proposed Action represents little to no change in the actual level of recent or current tribal use of the federal lands. At the same time, the Land Exchange Proposed Action brings as many as 7,075.0 acres of private land into the public domain, making it accessible for tribal use.

When compared with the Land Exchange No Action Alternative, the Land Exchange Proposed Action and the Land Exchange Alternative B would provide a slight improvement in key indicators described in Section 5.3.1.1. The Land Exchange Proposed Action provides for more of an improvement in overall indicators than under the Land Exchange Alternative B. The Land Exchange Proposed Action and the Land Exchange Alternative B are both compatible with adjacent zoning and management area designations.

There is no current legacy contamination on the non-federal parcels. Past legacy contamination concerns are discussed in Section 4.3.1.

5.3.1.1 Methodology and Evaluation Criteria

The area of analysis for land use effects from the Land Exchange Proposed Action included the federal and non-federal tracts, as well as properties abutting the tracts, which provide the basis for determining compatibility of land uses on the federal and non-federal parcels. The temporal analysis is based on the time of change in ownership. Management areas and subsequent land uses would be established at the time of the ownership change.

The analysis of the land use resources affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and the other Co-lead Agencies. The following impact indicators identify anticipated outcomes of the Land Exchange Proposed Action alternatives being considered for the NorthMet Project Proposed Action:

- net change in the number of acres controlled by the USFS on the Superior National Forest;
- net change in the length of the boundary around USFS-controlled land in the Superior National Forest (including internal boundaries around private in-holdings) to be managed under each of the proposed alternatives;
- net change in the level of land fragmentation, expressed as a ratio of linear boundary-to-area (linear miles per acre) of the USFS-controlled portions of the Superior National Forest under each of the proposed alternatives;
- the degree of access to lands owned by the USFS in the Superior National Forest, as determined through the identification of public access points via road or trail;

- degree of compatibility between USFS management areas and zoning or land use designations (in the absence of zoning) of adjacent areas;
- potential for mineral development within the parcels, assessed by the USFS based on mineral ownership, the type of mineral, and the precedent/history for exploitation of this mineral within Minnesota; and
- quality of title within each of the parcels being considered. Quality was evaluated by the USFS according to outstanding encumbrances on the parcels considered for each of the Land Exchange Proposed Action alternatives, including mineral ownership and development potential.

Quantitative criteria, such as boundary length and land area, were calculated using GIS. Evaluations of mineral development potential were conducted by third party professional geologists (Barr 2011c). The risk of conflict between mineral interests and USFS surface management and quality of title were assessed by a USFS Forest Realty Specialist.

5.3.1.2 Land Exchange Proposed Action

5.3.1.2.1 Forest Available for Public Access and Use

Through the Land Exchange Proposed Action, 6,495.4 acres of federal lands in the Superior National Forest would be transferred to PolyMet in exchange for up to approximately 7,075.0 acres of non-federal lands presently in private ownership. This would result in a net increase of approximately 579.5 acres for the Superior National Forest. All of the non-federal lands are within the 1854 Ceded Territory and would thus be accessible for use by the Bands. Table 5.3.1-1 shows the Management Area designations that the USFS would apply to the non-federal lands under the Land Exchange.

Table 5.3.1-1 Management Area Allocations under the Land Exchange Proposed Action

	Acreage by Management Area[1]				
Tract	**General Forest**	**General Forest-Longer Rotation**	**Riparian Emphasis Areas**	**cRNA[5]**	**Total[6]**
Federal Lands[2]	**355.3**	**6,140.1**	**0.0**	**0.0**	**6,495.4**
Non-federal Lands[3]					
Tract 1	4,619.3	0.0	0.0	306.9	4,926.2
Tract 2	0.0	161.0	220.9	0.0	381.9
Tract 3	1,450.0	125.8	0.0	0.0	1,575.8
Tract 4	0.0	160.2	0.0	0.0	160.2
Tract 5	0.0	30.8	0.0	0.0	30.8
Subtotal, Non-federal Lands	6,069.3	477.8	220.9	306.9	7,074.9
Net Change[4]	5,714.0	(5,662.3)	220.9	306.9	579.5

Notes:
[1] See definitions of USFS Management Areas in Section 4.2.3.
[2] Source: USFS 2011a.
[3] Source: USFS 2011b.
[4] Calculated as (non-federal) minus (federal).
[5] Candidate Research Natural Area (see Section 4.2.3).
[6] Totals may not match overall NorthMet Project area acreages due to rounding.

The 6,495.4 acres of federal lands are not accessible for public use (see Section 4.2.11), while substantial portions of the non-federal lands do have public access. This distinction is a factor in evaluating land use effects because public access defines the degree to which the lands in question can actually be used—either by the public for recreational purposes, by forestry interests for economic purposes, or for research and conservation purposes (in the case of Riparian Emphasis and cRNA management areas, defined in Section 4.3.1). Tract 1 has direct public access via existing county roads (see Figure 5.3.1-1), and Tracts 4 and 5 also have public access via other roads (see Figure 5.3.1-2). Tracts 2 and 3 have no direct public access (Figure 5.3.1-1). When considered collectively, public access to, and therefore use of the Superior National Forest, would be increased under the Land Exchange Proposed Action.

Table 5.3.1-2 shows the effect of the Land Exchange Proposed Action on the total acreage within the Superior National Forest that is controlled by the USFS, the boundary of the USFS-controlled land (see Section 5.3.1.2.2), and the fragmentation ratio (see Section 5.3.1.2.3). The Land Exchange Proposed Action would increase the federal estate by adding a net of approximately 518.7 acres to the 2,172,764.0 acres of USFS-controlled land within the Superior National Forest.

Table 5.3.1-2 Superior National Forest Boundary, Acreage, and Fragmentation under the Land Exchange Proposed Action

	Baseline / No Action	Land Exchange Proposed Action	
		Predicted Value	Net Increase (Decrease)[1]
Acreage in Superior National Forest controlled by USFS	2,172,764.0	2,173,282.7	518.7
Boundary length (linear miles)	10,761.9	10,733.9	(28.0)
Fragmentation (linear miles per acre)	0.005	0.005	0.00

Notes:
[1] Totals differ from acreage reported in Section 5.3.1.2.1 (579.5 acres) due to inconsistencies in GIS data and because USFS would not take control of Hay Lake (31.5 acres).

5.3.1.2.2 Boundary Managed

A reduced boundary length is more desirable for the USFS, because it reduces the difficulty of accessing and managing the forest. The Land Exchange Proposed Action would result in a 28.0-mile net reduction of the perimeter around the USFS-controlled portions of the Superior National Forest (see Table 5.3.1-2).

5.3.1.2.3 Forest Fragmentation

The underlying assumption regarding land fragmentation of USFS-controlled portions of the Superior National Forest is that a lower ratio of boundary to area is more desirable, because it reduces the difficulty of accessing and managing the forest in addition to increasing the forest's overall quality and function. All of the non-federal parcels are contiguous with National Forest System lands, thus decreasing the ratio of boundary to area. The Land Exchange Proposed Action would not alter the existing ratio of fragmentation in the Superior National Forest of approximately 0.005 linear miles of boundary per acre of USFS-controlled Superior National Forest land (see Table 5.3.1-2).

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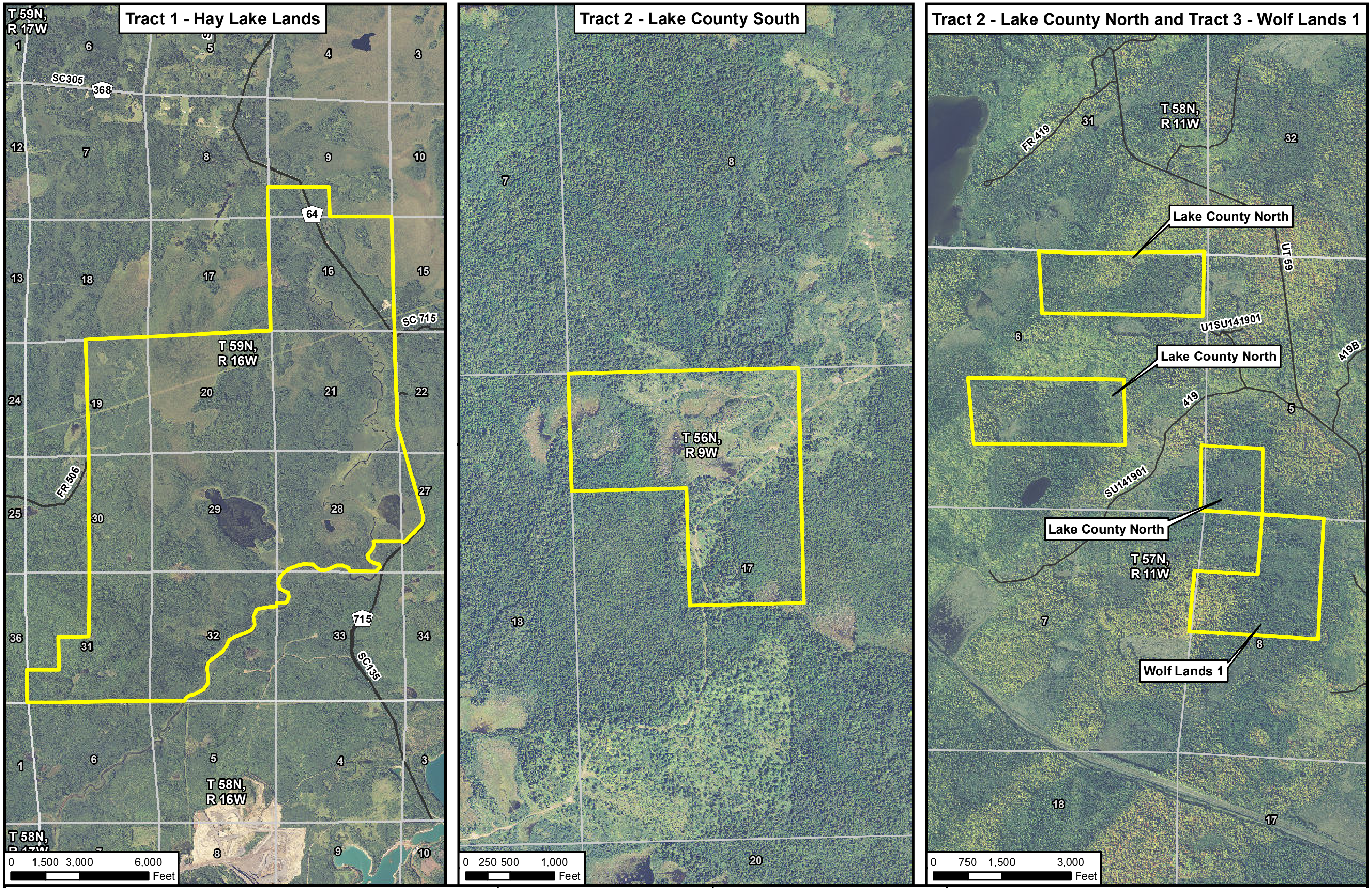

Non-federal Lands

Section Boundary

1 Section Label

Road

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N W E S

Figure 5.3.1-1

Tracts 1, 2 and 3 Roads

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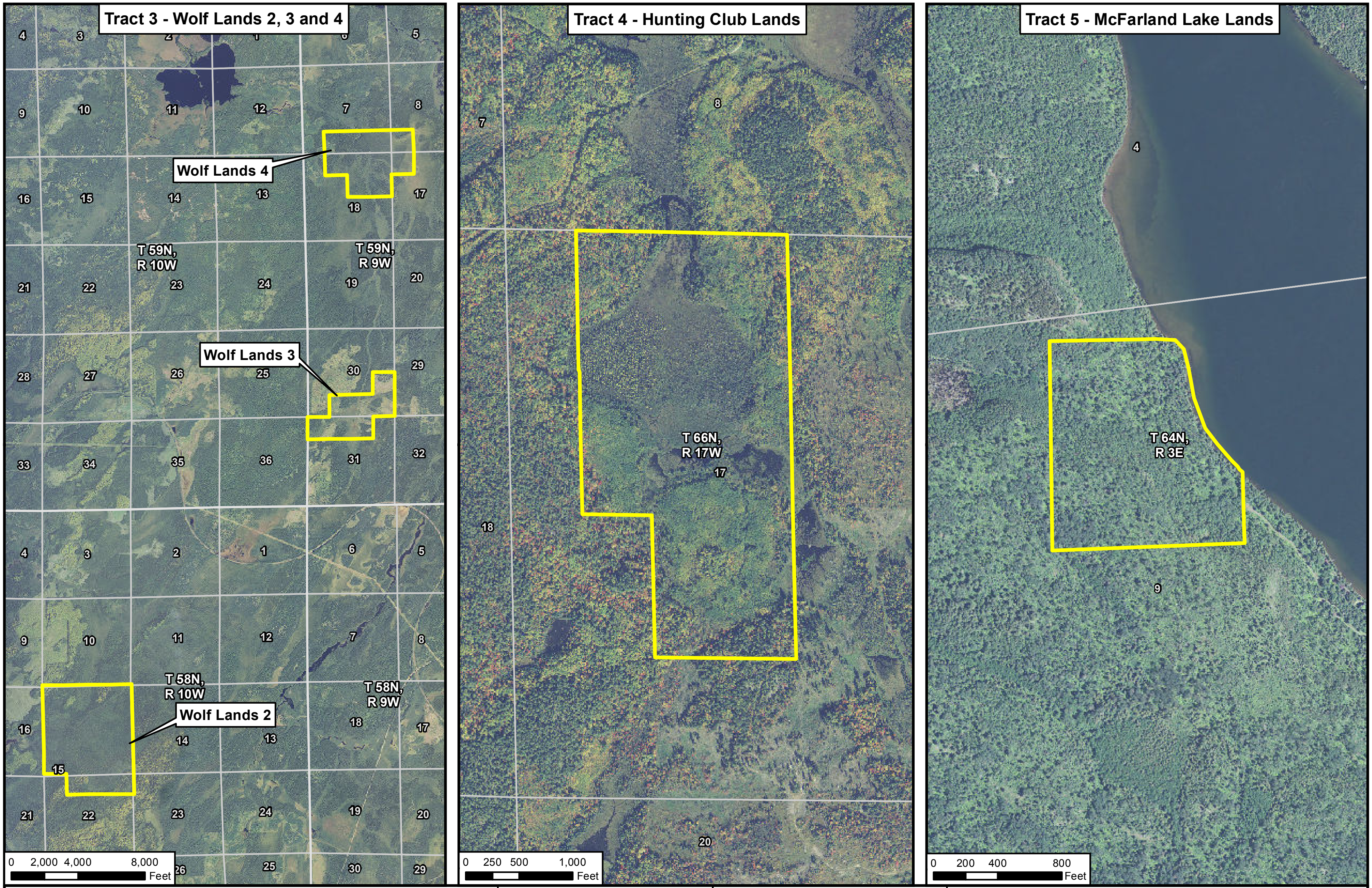

Non-federal Lands

Section Boundary

1 Section Label

Road

Minnesota Department of Natural Resources

US Army Corps of Engineers St. Paul District

Forest Service U.S. Department of Agriculture

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Figure 5.3.1-2

Tracts 3, 4 and 5 Roads

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5.3.1.2.4 Zoning Compatibility

Management area designations for national forests are largely determined by the desired (or existing) vegetative community in a given location (see Section 5.3.4.2.1). In addition, Management Area designations provide guidance regarding public use of National Forest System lands (e.g., recreation, scenic resources, and facilities). Section 4.3.1 provides definitions of the intended uses of the management area designations that apply to the federal and non-federal tracts, as well as surrounding areas within the Superior National Forest.

Zoning in areas adjacent to the non-federal lands outside of the Superior National Forest and compatibility with the management area designations of non-federal lands are summarized below:

- Zoning on privately owned ("non-forest") lands adjacent to Tract 1 is split among multiple zoning districts, including residential, wild rice production, timber, and hunting (St. Louis County 2011), all of which are compatible with the proposed General Forest and cRNA management area designation of Tract 1. Non-forest lands to the east and south of Tract 1 are in the Multiple-Use Non-Shoreland (MUNS-4) district (St. Louis County 2011), which is generally compatible with the General Forest and cRNA management areas.
- Non-forest lands adjacent to Tracts 2 and 3 are in the Forest-Recreation district, as defined by the Lake County Zoning Ordinance (Nelson, Pers. Comm., October 10, 2011). This is compatible with the proposed General Forest, General Forest – Longer Rotation, and Riparian Emphasis Area Management Area designations.
- Non-forest lands adjacent to Tract 4 to the west and southeast are within the St. Louis County FAM-1 zoning district, which emphasizes forestry, agricultural, and recreational uses (St. Louis County 2011). These uses are generally compatible with the proposed General Forest – Longer Rotation Management Area designation.
- Privately owned lands adjacent to Tract 5 to the north and southeast are within Cook County's Recreational Development zoning district (Cook County 2011), which is generally compatible with the proposed General Forest – Longer Rotation Management Area.

Overall, the management area designations of the non-federal lands are compatible with surrounding zoning. The Land Exchange Proposed Action would be compatible with the USFS Management Areas and zoning/land use designations of adjacent lands.

5.3.1.2.5 Mineral Development Potential and Quality of Title

The Land Exchange Proposed Action would remove from the Superior National Forest 6,495.4 acres of land with privately held, minable mineral development potential and USFS-held surface rights, in exchange for up to approximately 7,075.0 acres of non-federal land with a low mineral development potential. As described in Section 3.3, the Land Exchange would unite the mineral and surface rights on the federal parcel under PolyMet ownership, fulfilling the USFS's purpose and need.

Table 5.3.1-3 summarizes the risk of conflict between mineral potential and the USFS surface management objectives on each of the non-federal parcels, as well as the overall quality of title to the land.

Table 5.3.1-3 Mineral Interests and Quality of Title for Non-Federal Lands

Tract/Parcel	Risk of Conflict Between Mineral Interests and USFS Surface Management[1]	Quality of Title[2,3]
1: Hay Lake	Moderate	Moderate
2: Lake County North	Low	Moderate
2: Lake County South	Low	Moderate
3: Wolf Lands 1	Low	Moderate
3: Wolf Lands 2	Low	Moderate
3: Wolf Lands 3	Low	Moderate
3: Wolf Lands 4	Low	Moderate
4: Hunting Club	Low	High
5: McFarland Lake	Low	Moderate

Source: USFS 2011c.

Notes:
1 Low is the best and high is the worst, as defined in USFS 2011c and Barr 2011c.
2 Condition of title represents review as of December 21, 2011 -- may be revised per specialist investigation or advice of USDA, Office of General Counsel.
3 High is the best and poor is the worst, as defined in USFS 2011c.

The risk of conflict determination in Table 5.3.1-3 expresses the degree to which "split estate" conditions could complicate achievement of USFS management goals and objectives. Split estate refers to situations where private ownership of mineral rights would occur on land whose surface is owned by the Superior National Forest after the Land Exchange Proposed Action. This concern notwithstanding, the USFS allows exploration, development, and production of mineral resources on National Forest System lands under conditions where the activities "are conducted in an environmentally sound manner so that they may contribute to economic growth and national defense" (USFS 2004b).

The "moderate" risk of conflict on Tract 1 reflects the presence of potential surficial aggregate resources in the far northeastern corner of the tract. There are also some potential surficial aggregate resources near Greenwood Lake in Tract 3, but development of these resources is constrained due to the presence of wetlands, which may limit or prohibit access (Barr 2011c). For all other tracts, the risk of conflict is low due to the low potential for mineral development.

The quality of title determination assesses existing uncertainties in surface ownership, title insurance, or other encumbrances that may be transferred to the USFS in the event of the Land Exchange moving forward, as well as the risk of conflict defined above. Details of the quality of title determination are presented below by tract (USFS 2011c):

- Tract 1: Moderate, due to the presence of surficial aggregate resources in the northeastern portion of the site and uncertainties with title insurance.
- Tract 2: Moderate, due to the presence of privately held mineral exploitation rights. This potential is constrained by the low potential presence of subsurface mineral resources and the absence of surficial deposits.
- Tract 3: Moderate, due to the presence of privately held mineral exploitation rights on portions of all Tract 3 parcels and the presence of private timber rights for one parcel. Mining potential is constrained by the low potential presence of subsurface mineral resources, the absence of surficial deposits, and the presence of wetlands that may make mineral exploitation difficult.

- Tract 4: High, due to the lack of privately held mineral or timber rights.
- Tract 5: Moderate, due to the potential for privately held mineral exploitation rights. This potential is constrained by the low potential presence of subsurface mineral resources and the absence of surficial deposits.

By comparison, the risk of conflict between mineral and surface rights on the federal lands is high due to the presence of severed private mineral rights and known, minable minerals, and USFS surface ownership. The Land Exchange Proposed Action would reduce this risk by exchanging the high-risk federal lands for predominantly low-risk non-federal lands. The risk of conflict on the non-federal lands may be reduced and title quality further improved through subsequent arrangements with holders of mineral rights on the non-federal lands. Thus, the overall effect of the Land Exchange Proposed Action improves the quality of title and reduces the complexity of title to the federal and non-federal lands.

5.3.1.3 Land Exchange Alternative B

5.3.1.3.1 Forest Available for Public Access and Use

Under the Land Exchange Alternative B, 4,752.6 acres of federal lands would be transferred to private ownership in exchange for up to approximately 4,926.3 acres of land (Tract 1 only) currently in private ownership, resulting in a net increase of approximately 173.6 acres for the Superior National Forest. The federal lands transferred out of the Superior National Forest in this scenario have poor public access (see Section 4.3.11). The smaller federal parcel would leave an isolated island of federal lands to the west of the Mine Site. These federal lands would be difficult to access as the railroad and road are private property. Access points managed by the USFS to the isolated area are limited. The non-federal tract has relatively good public access. The approximately 173.6 acres of additional federal estate lands are included in the 1854 Ceded Territory, and would thus be accessible to the Bands. Table 5.3.1-4 shows the management area designations that the USFS would apply to the non-federal lands under the Land Exchange Alternative B.

Table 5.3.1-4 Management Area Allocations under the Land Exchange Alternative B

	Acreage by Management Area[1]				
Tract	**General Forest**	**General Forest-Longer Rotation**	**Riparian Emphasis Areas**	**cRNA[5]**	**Total[6]**
Federal lands[2]	355.3	4,397.3	0.0	0.0	4,752.6
Non-federal lands[3]					
Tract 1	4,619.3	0.0	0.0	306.9	4,926.2
Net Change[4]	**4,264.0**	**(4,397.3)**	**0.0**	**306.9**	**173.6**

Notes:
1 See definitions of USFS Management Areas in Section 4.2.3.
2 Source: USFS 2011a.
3 Source: USFS 2011b.
4 Calculated as (non-federal) minus (federal)
5 Candidate Research Natural Area (see Section 4.2.3).
6 Totals may not match overall project area acreages due to rounding.

Table 5.3.1-5 shows the effect of the Land Exchange Alternative B on the total acreage within the Superior National Forest that is controlled by the USFS, the boundary of the USFS-controlled land (see Section 5.3.1.4.2), and the fragmentation ratio (see Section 5.3.1.4.3). The Land Exchange Alternative B would increase the federal estate by a net of approximately 70.6 acres to the 2,172,764.0 acres of USFS-controlled land within the Superior National Forest.

Table 5.3.1-5 Superior National Forest Boundary, Acreage, and Fragmentation for the Land Exchange Alternative B

	Baseline/ No Action	Proposed Action	
		Predicted Value	Net Gain (Loss)[1]
Acreage in Superior National Forest controlled by USFS	2,172,764.0	2,172,906.1	142.1
Boundary length (linear miles)	10,761.9	10,755.6	(6.3)
Fragmentation (linear miles per acre)	0.005	0.005	0.00

Notes:
[1] Totals differ from acreage reported in Table 5.3.1-4 (173.6 acres) because USFS would not manage Hay Lake (31.5 acres).

5.3.1.3.2 Boundary Managed

The Land Exchange Alternative B would result in a 6.3-mile net reduction of the perimeter around the USFS-controlled portions of the Superior National Forest (see Table 5.3.1-5).

5.3.1.3.3 Forest Fragmentation

The Land Exchange Alternative B would not decrease the fragmentation ratio in USFS-controlled portions of the Superior National Forest (see Table 5.3.1-5).

5.3.1.3.4 Zoning Compatibility

Under the Land Exchange Alternative B, forest lands on the western boundary of the smaller federal parcel would remain within the Superior National Forest, and would retain their General Forest – Longer Rotation Management Area designation. This management area is compatible with nearby mining activity. There is no existing public access to this portion of the Superior National Forest, and it is reasonable to expect that access would remain restricted for health and safety reasons for the anticipated life of the mine.

The proposed management area designation for Tract 1 under the Land Exchange Alternative B would be the same as in the Land Exchange Proposed Action (see Section 5.3.1.2.4). The Land Exchange Alternative B would be compatible with the USFS management areas and zoning/land use designations of adjacent lands.

5.3.1.3.5 Mineral Development Potential and Quality of Title

The Land Exchange Alternative B would remove 4,752.6 acres of forest lands with proven development potential from the Superior National Forest, in return for up to 4,926.3 acres with moderate mineral development potential, except for potential surficial aggregate resources in the far northeastern corner of Tract 1 (Barr 2011c). The risk of conflict and quality of title for the Land Exchange Alternative B is the same as for Tract 1 in the Land Exchange Proposed Action (see Table 5.3.1-3).

As with the Land Exchange Proposed Action, the Land Exchange Alternative B would result in a reduced risk of conflict and improved quality of title. The Land Exchange Proposed Action would result in relinquishing the federal parcel with severed, private mineral rights and known, minable minerals and acquiring parcels with low to moderate risk of conflict and moderate to high title quality. The risk of conflict and title quality may be further improved through subsequent arrangements with mineral rights holders. Thus, the Land Exchange Alternative B would also benefit efforts to manage the Superior National Forest, although to a lesser degree than the Land Exchange Proposed Action.

Mineral rights to the Mine Site are held by PolyMet, while surface rights are held by USFS, creating a conflict between surface and mineral rights. As described in Section 3.3, the USFS's Purpose and Need is to resolve the conflict between surface and mineral rights through a land exchange (see Section 5.3.1).

The Land Exchange Proposed Action would be consistent with this Purpose and Need, as well as existing land use designations surrounding the Mine Site. Therefore, the Land Exchange Proposed Action would have no adverse effect on land use at the Mine Site. Effects on recreational and natural resource use at the Mine Site are addressed in other sections of this chapter.

5.3.1.4 Land Exchange No Action Alternative

The Land Exchange No Action Alternative represents no change to current land use on the federal and non-federal lands. There would be no change in the amount of forest boundary managed, level of forest fragmentation, or acres available for public access and use.

Under the Land Exchange No Action Alternative, interest in development of mineral potential on the federal lands could continue, and would be compatible with relevant local zoning ordinances and planning designations. The Land Exchange No Action Alternative is also compatible with the General Forest and General Forest – Longer Rotation Management Area classifications. However, the mineral rights would remain severed from federal ownership. The potential conflict between mineral interests and USFS surface management of the federal parcel would remain.

The presence of a privately owned road (Dunka Road) and rail on the southern border of the federal lands would continue to limit public access to and use of the federal lands, as envisioned by the management area designations.

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5.3.2 Water Resources

This section describes the potential effects and compares the resource value of the Land Exchange Proposed Action on water resources of the federal and non-federal lands to be exchanged, as well as for Land Exchange Alternative B and the Land Exchange No Action Alternative. The effects on the federal and non-federal lands are discussed together to facilitate comparison between the water resources of the lands exchanged. The total yield and quality of surface and groundwater currently leaving the non-federal tracts and flowing into the federal estate would not be altered by any of the Land Exchange alternatives. Under the Land Exchange Proposed Action and alternatives, the Superior National Forest would retain its ongoing responsibility for managing water resources on USFS lands in accordance with the Forest Plan. Table 5.3.2-1 shows the effects of the Land Exchange Proposed Action and Land Exchange alternatives on acreage of surface water and wild rice beds.

Under the Land Exchange Proposed Action, a net increase of 122.0 acres of DNR-designated public water lakes (2.1 miles of shoreline) and 7.0 miles of public water streams would be added to the federal estate. By comparison, under Land Exchange Alternative B, a net increase of 145.0 acres of public water lakes (2.5 miles of shoreline) and 4.5 miles of public water streams would be added to the federal estate. One difference is that, under the Land Exchange Proposed Action, all of Mud Lake (33 acres) would be exchanged for the private lands, while under Land Exchange Alternative B only about 10 acres of Mud Lake would be included in the land exchange. Both the Land Exchange Proposed Action and Land Exchange Alternative B would result in a net increase of wild rice beds. Hay Lake Lands (Tract 1) contain known wild rice beds (approximately 155 acres).

Table 5.3.2-1 Net Change in Surface Water and Wild Rice Beds to the Federal Estate Resulting from the Land Exchange Proposed Action Compared to the Land Exchange Alternative B

	Net Increase (Decrease) of Water Resources			
Alternative	**Public Water Lakes acres**	**Public Water Lakes miles of shoreline**	**Public Water Streams miles**	**Wild Rice Beds acres**
Proposed Action	122.0	2.1	7.0	>155[1]
Alternative B	145.0	2.5	4.5	>155[1]
No Action	0	0	0	0

[1] Excludes area of wild rice beds in Pike River. Presence of wild rice in the Pike River, which runs through Little Rice Lake, was noted in Barr's surveys (Barr 2010a, 2011a and 2012a), but the area of rice was not calculated.

There is limited groundwater or surface water quality data available for the non-federal tracts, with the exception of sulfate data for the Hay Lake Lands. There are, however, no known reasons to suspect surface water or groundwater contamination of any of the tracts from human activities. In general, water quality is expected to reflect natural conditions as similar to that found from MPCA regional studies (see Section 4.3.2.2.3).

5.3.2.1 Methodology and Evaluation Criteria

The area of analysis for water resource effects of the Land Exchange alternatives included the federal and non-federal tracts proposed for the exchange.

Since the Land Exchange Proposed Action would not actually result in any direct effects, as there are no construction or other activities proposed that would affect water resources, this assessment focuses on a comparison of the net change in the quantity and quality of water resources between the federal and non-federal tracts involved in the exchange.

5.3.2.1.1 Groundwater Evaluation Criteria

Groundwater resource evaluation criteria for the Land Exchange Proposed Action include a qualitative assessment of potential for groundwater contamination of the non-federal properties using MDNR and MPCA groundwater quality data.

5.3.2.1.2 Surface Water and Wild Rice Evaluation Criteria

Surface water evaluation criteria for the Land Exchange Proposed Action include a comparison of the length of public water streams/rivers, public water lake acreage, and shoreline length between the federal and non-federal lands. This was used to determine the net change in quantity of waterbodies. In addition, a qualitative assessment of surface water quality was conducted taking into consideration available water quality data, aerial photographs, and GIS information.

Wild rice evaluation criteria include a comparison in the amount of known or potential wild rice beds between federal and non-federal lands. This was used to determine the potential change in acres of wild rice on the federal estate. Information that was used in the analysis of wild rice beds included available field data; aerial photographs, and GIS layers.

5.3.2.2 Land Exchange Proposed Action

The Land Exchange Proposed Action would involve the transfer of 6,495.4 acres of federal lands from public to private ownership, and up to approximately 7,075 acres of private land to public ownership (Figure 3.3-1).

5.3.2.2.1 Groundwater

The Land Exchange Proposed Action would not directly result in a change in groundwater quantity or quality presently at the non-federal tracts. Evaluation of existing hydrogeologic data did not suggest the potential for groundwater contamination from human activity from any of the tracts. Therefore, there does not appear to be any substantive difference in the quality of groundwater resources between the federal and non-federal tracts.

5.3.2.2.2 Surface Water and Wild Rice

The Land Exchange Proposed Action would not directly result in a change in surface water quantity or quality at the non-federal tracts. There would be a net increase to the federal estate of about 7 miles of public water streams, about 122 acres of public water lakes(including 2.1 miles of additional shoreline), and at least 155 acres of wild rice beds under the Land Exchange Proposed Action.

Table 5.3.2-2 summarizes the federal and non-federal surface water resources and shows the net changes in these resources to the federal estate that would result from the Land Exchange Proposed Action. The Hay Lake Lands (Tract 1) account for the majority of the net gain in surface water and wild rice beds to the federal estate from all the non-federal lands.

Table 5.3.2-2 Net Change in Surface Water and Wild Rice Beds to the Federal Estate (Land Exchange Proposed Action)

	Surface Water Resource			
	Public Water Lakes, acres	**Public Water Lakes, miles shore**	**Public Water Streams, miles**	**Wild Rice Beds, acres**
	Lands Conveyed			
Federal Lands	33.0	0.9	3.5	0.0
	Lands Acquired			
Tract 1 – Hay Lake	155.0	2.8	8.0	>155.0[1]
Tract 2 – Lake County	0.0	0.0	0.5	0.0
Tract 3 – Wolf Lands	0.0	0.0	2.0	0.0
Tract 4 – Hunting Club	0.0	0.0	0.0	0.0
Tract 5 – McFarland	0.0	0.2	0.0	0.0
Subtotal: Non-federal Lands	155.0	3.0	10.5	>155.0[1]
Net Increase (Decrease)	**122.0**	**2.1**	**7.0**	**>155.0[1]**

[1] Excludes area of wild rice beds in Pike River.

5.3.2.3 Land Exchange Alternative B

Under the Land Exchange Alternative B, approximately 4,753 acres of federal lands would be transferred from public to private ownership, and 4,926.3 acres of land from private to public ownership, for a net increase in 173.7 acres in the federal estate (Figure 3.3-2).

5.3.2.3.1 Groundwater

The Land Exchange Alternative B would not directly result in a change in groundwater quantity or quality at the non-federal tracts. Evaluation of existing hydrogeologic data did not suggest the potential for groundwater contamination from human activity from any of the tracts. Therefore, there does not appear to be any substantive difference in the quality of groundwater resources between the federal and non-federal tracts.

5.3.2.3.2 Surface Water and Wild Rice

The Land Exchange Alternative B would not directly result in a change in surface water quantity or quality at the non-federal tracts. There would be a net increase to the federal estate of about 4.5 miles of public water streams, under Land Exchange Alternative B. There would also be a net increase of about 145 acres of public water lake area (including 2.5 miles of shoreline) and at least 155 acres of wild rice beds under the Land Exchange Alternative B.

Table 5.3.2-3 summarizes the federal and non-federal surface water resources and shows the net changes in these resources to the federal estate that would result from the Land Exchange Alternative B.

Table 5.3.2-3 Net Change in Surface Water and Wild Rice Beds to the Federal Estate (Land Exchange Alternative B)

	Surface Water Resource			
	Public Water Lakes, acres	**Public Water Lakes, miles shore**	**Public Water Streams, miles**	**Wild Rice Beds, acres**
		Lands Conveyed		
Federal Lands	10.0	0.3	3.5	0.0
		Lands Acquired		
Tract 1 – Hay Lake	155.0	2.8	8.0	>155.0[1]
Net Increase (Decrease)	**145.0**	**2.5**	**4.5**	**>155.0[1]**

[1] Excludes area of wild rice beds in Pike River.

5.3.2.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Land Exchange Proposed Action would not take place and would result in no changes in existing water resources under federal ownership. The Superior National Forest would have an ongoing responsibility for managing water resources on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS responsibility for managing water resources.

5.3.3 Wetlands

This section describes the potential environmental consequences of the Land Exchange Proposed Action on wetland resources that occur on the federal and non-federal lands. In this section, effects on the federal and non-federal lands are discussed together, to facilitate calculation of net changes to wetland resources. Under the Land Exchange Proposed Action and alternatives, the Superior National Forest would retain its ongoing responsibility for managing wetland resources on Forest Service lands in accordance with the Forest Plan. Table 5.3.3-1 shows a summary of the effects of the Land Exchange Proposed Action and Land Exchange Alternative B on acreage of wetland and floodplains, Table 5.3.3-2 summarizes the effects on wetland resource types, and Table 5.3.3-3 summarizes the effects on other water resources.

Table 5.3.3-1 Net Increase or Decrease of Wetland and Floodplain Acres from the Land Exchange

	Increase (or Decrease) of Wetland and Floodplain Acres	
Alternative	**Wetlands (Acres)**	**Floodplains (Acres)**
Land Exchange Proposed Action	505.5	(1,401.0)
Land Exchange Alternative B	69.8	(1,036.7)

Table 5.3.3-2 Net Increase or Decrease of Wetland Resource Types from the Land Exchange

	Increase (or Decrease) of Wetland Resource Types (Acres)								
Alternative	**Coniferous Bog**	**Coniferous Swamp**	**Deep Marsh**	**Hardwood Swamp**	**Open Bog**	**Open Water (includes shallow, open water, and lakes)**	**Sedge/Wet Meadow**	**Shallow Marsh**	**Shrub Swamp (includes alder thicket and shrub-carr)**
Land Exchange Proposed Action	(1,961.4)	1,954.7	0.0	36.9	(118.3)	151.7	(35.7)	(63.6)	541.3
Land Exchange Alternative B	(1,677.0)	1,477.8	0.0	(5.7)	(88.8)	168.0	(34.9)	(80.9)	311.4

Table 5.3.3-3 Net Increase or Decrease of Frontage of Waterways from the Land Exchange

	Increase (or Decrease) of Frontage of Waterways					
	Lake			River/Stream/Creek		
Alternative	**Acres**	**Frontage (ft)**	**Length of Lake Frontage/Acre**	**Miles**	**Frontage (linear ft)**	**Length of River Frontage/Acre**
Proposed Land Exchange	111.0	13,450.0	34.9	4.5	34,214.4	46.0
Land Exchange Alternative B	132.6	15,900.0	3.2	3.1	19,536.0	3.6

Source: Data from Section 4.3.3.

Overall, the Land Exchange Proposed Action would increase wetland acreage by 505.5 acres through the acquisition of up to 7,075.0 acres of non-federal lands in exchange for 6,495.4 acres of federal land, and thus would be in conformity with EO 11190. The Land Exchange Proposed Action would result in a net decrease of 1,401.0 acres of floodplains; however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain, no increase in the flood damage potential, and the ecological function of the floodplain would not change; therefore, the Land Exchange Proposed Action would be in conformance with EO 11988. The Land Exchange Proposed Action would result in an increase of coniferous swamp, hardwood swamp, open water, and shrub swamp wetland resources but would result in a decrease of coniferous bog, open bog, sedge/wet meadows, and shallow marsh wetland resources. In addition, the Land Exchange Proposed Action would result in an increase in waterway acreage and frontage to the federal estate.

Due to the reduced land area involved, Land Exchange Alternative B would result in a lesser degree of the same types of effects for wetlands, floodplains, and other water resources as the proposed Land Exchange Proposed Action. Overall, Land Exchange Alternative B would increase wetland areas by 69.8 acres through the acquisition of up to 4,926.3 acres of the non-federal lands in exchange for 4,752.6 acres of federal land, and would thus be in conformity with EO 11190. The Land Exchange Alternative B would decrease the amount of floodplains by 1,036.7 acres; however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain, no increase in the flood damage potential, and the ecological function of the floodplain would not change; therefore, the Land Exchange Alternative B would be in conformance with EO 11988. Land Exchange Alternative B would result in an increase of coniferous swamp, open water, and shrub swamp wetland resources but would result in a decrease to coniferous bog, hardwood swamp, open bog, sedge/wet meadows, and shallow marsh wetland resources. In addition, Land Exchange Alternative B would result in an increase of waterway acreage and frontage to the federal estate.

Based on a qualitative assessment, the Land Exchange Proposed Action and Land Exchange Alternative B would appear to result in an increase of wetlands rated as high for vegetation diversity/integrity, wetland water quality, fish habitat, and amphibian habitat. Land Exchange Alternative B would also appear to result in an increase of wetlands rated as high for hydrology and wildlife habitat. The Land Exchange Proposed Action would result in an increase of moderate and low rated wetlands for amphibian habitat, as where Land Exchange Alternative B would also result in an increase of wetlands rated low for amphibian habitat. The Land Exchange Proposed Action would have similarly rated hydrology, flood attenuation, downstream water quality, wildlife habitat, and aesthetics/education/cultural functions. Land Exchange Alternative B would result in a decrease of wetlands rated high and moderate for flood attenuation and downstream water quality and would not result in a change to aesthetics/education/cultural functions.

5.3.3.1 Methodology and Evaluation Criteria

The potential effect that the Land Exchange Proposed Action and alternatives would have on wetland resources was evaluated using two types of criteria: 1) criteria assessing conformity to EOs 11190 and 11988, which requires a wetland acre-for-acre analysis and a floodplain acre-for-acre analysis of the federal estate, and 2) criteria used in an analysis of wetlands and floodplain habitat, as well as other water resource indicators.

As previously discussed, to satisfy the requirements of EOs 11990 and 11988, the USFS uses a balancing test such that, as much as practicable, the number of wetland and floodplain acres on the non-federal land to be acquired is equal to, or greater than, the number of wetland and floodplain acres on the federal land to be exchanged. When balancing wetlands, the agency makes no distinction between type and/or quality of wetlands. If the number of wetland and floodplain acres on the non-federal estate cannot be made equal to the acres on the federal estate, the USFS may retain reservations or restrictions on the unbalanced portion of the wetlands and floodplains, so long as the land exchange is in the public interest.

In addition to evaluating wetlands in accordance with the two EOs, analysis of the Land Exchange included information on wetland community types as well as ecological floodplains.

To evaluate conformity to the EOs, the following evaluation criteria were used:

- comparative difference in acres of wetland between the federal and non-federal parcels; and
- comparative difference in acres of floodplain between the federal and non-federal parcels.

Other wetland resources indicators that were used are the following:

- comparative difference in acres of wetland types between the federal and non-federal parcels;
- a MnRAM assessment of wetland function and value;
- change in flood damage potential on the parcels and to the surrounding parcels;
- a MnRAM assessment of floodplain assets; and
- comparative difference of length of streams, rivers, and lake frontage between the federal and non-federal parcels.

The spatial area of analysis for wetland resource effects from the Land Exchange Proposed Action and alternatives included the federal and non-federal tracts proposed for the exchange, while the temporal area of analysis assessed was the point in time at which the change in ownership would occur.

The analysis of the wetland resources affected by the Land Exchange Proposed Action and alternatives was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies, which included a comparison of wetland resource acreages, wetland resources types, wetland function and values, floodplain acreages, and other water resources acreages. GIS data and field observations were used and then compared over an area of analysis that included the federal and non-federal lands.

5.3.3.1.1 Wetlands and Floodplains

The federal lands contain approximately 4,164 acres of wetlands (see Table 5.3.3-4). By comparison, the five non-federal land tracts contain approximately 4,670 acres of wetlands. The Land Exchange Proposed Action would result in a net increase of 505.5 acres of wetlands to the federal estate if all five tracts are exchanged (Table 5.3.3-4). The Land Exchange Proposed Action would increase wetland acreage by 505.5 acres through the acquisition of up to 7,075.0 acres of non-federal lands in exchange for 6,495.4 acres of federal land, and thus would be in conformity with EO 11190. The Land Exchange Proposed Action would result in a net decrease of 1,401.0 acres of floodplains; however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain, no increase in the flood damage potential, and the ecological function of the floodplain would not change; therefore, the Land Exchange Proposed Action would be in conformance with EO 11988.

Table 5.3.3-4 Wetland and Floodplain Acres for the Land Exchange Proposed Action

Parcel		**Acres of Wetlands**	**Acres of Floodplains**
Lands Conveyed			
Federal Lands		4,164.4	1,889.4
Lands Acquired			
Tract 1		2,930.8	376.2
Tract 2	Lake County North	209.3	0
	Lake County South	73.6	0
Tract 3	Wolf Lands 1	90.4	0
	Wolf Lands 2	706.2	0
	Wolf Lands 3	233.2	32.8
	Wolf Lands 4	362.8	79.4
Tract 4		63.6	0
Tract 5		0	0
Subtotal: Non-federal lands		4,669.9	488.4
Net Change			
Net Increase/(Decrease)		505.5	(1,401.0)

As part of the increase in total wetland acreage, the Land Exchange Proposed Action would result in a net increase to the federal estate of the following wetland resource types (Table 5.3.3-5): coniferous swamp (1,954.7 acres), hardwood swamp (36.9 acres), open water (151.7 acres), and shrub swamp (541.3 acres). However, the Land Exchange Proposed Action would result in a net decrease to the federal estate of the following wetland resource types: coniferous bog (1,961.4 acres), open bog (118.3 acres), sedge/wet meadow (35.7 acres), and shallow marsh (63.6 acres).

Table 5.3.3-5 Wetland Resource Types for the Land Exchange Proposed Action

Parcel		Acres of Wetland Resource Types								
		Coniferous Bog	Coniferous Swamp	Deep Marsh	Hardwood Swamp	Open Bog	Open Water (includes shallow, open water, and lakes)	Sedge/Wet Meadow	Shallow Marsh	Shrub Swamp (includes alder thicket and shrub-carr)
Lands Conveyed										
Federal Lands		1961.4	1,287.8	0	21.1	209.5	30.8	35.7	97.0	521.1
Lands Acquired										
Tract 1		0	1,953.9	0	8	86.2	176.6	0	0	706.1
Tract 2	Lake County North	0	135	0	34.7	1.8	0.2	0	2.5	35.1
	Lake County South	0	32.4	0	9.9	0	2.5	0	12.3	16.5
Tract 3	Wolf Lands 1	0	75.4	0	0	3	0	0	0	12
	Wolf Lands 2	0	627.4	0	5	0	0.4	0	0.4	73
	Wolf Lands 3	0	82.6	0	0	0	0	0	5.2	145.4
	Wolf Lands 4	0	320.3	0	0	0.2	0	0	0	42.3
Tract 4		0	15.4	0	0.4	0	2.8	0	13	32
Tract 5		0	0	0	0	0	0	0	0	0
Subtotal: Non-federal lands		0	3,242.4	0.0	58.0	91.2	182.5	0.0	33.4	1,062.4
Net Change										
Net Increase/(Decrease)		(1,961.4)	1,954.7	0.0	36.9	(118.3)	151.7	(35.7)	(63.6)	541.3

5.3.3.1.2 Wetland Functional Assessment

Based on a qualitative assessment, the Land Exchange Proposed Action would appear to result in an increase of the following high rated wetland functions: vegetation diversity/integrity, wetland water quality, fish habitat, and amphibian habitat. The Land Exchange Proposed Action would result in an increase of moderate- and low-rated wetlands for amphibian habitat. The Land Exchange Proposed Action would have similarly rated hydrology, flood attenuation, downstream water quality, wildlife habitat, and aesthetics/education/cultural functions.

5.3.3.1.3 Frontage of Waterways

The Land Exchange Proposed Action would result in a net increase of other water resources to the federal estate (Table 5.3.3-6). A net increase of approximately 111 acres of lake and 4.5 miles of rivers will be added to the federal estate from the Land Exchange Proposed Action. These increases would result in additional frontage of lakes and rivers to the federal estate.

Table 5.3.3-6 Frontage of Waterways for the Land Exchange Proposed Action

		Lake			Rivers/Creeks/Streams		
Parcel		**Acres**	**Frontage (ft)**	**Length of Lake Frontage/Acre**	**Miles**	**Frontage (linear ft)**	**Length of River Frontage/Acre**
Lands Conveyed							
Federal Lands		30.5	4,550.0	0.7	5.1	53,856.0	8.3
Lands Acquired							
Tract 1		141.5	17,100.0	3.5	8.2	73,392.0	14.9
Tract 2		0.0	0.0	0.0	0.0	0.0	0.0
Tract 3	Wolf Lands 1	0.0	0.0	0.0	0.0	0.0	0.0
	Wolf Lands 2	0.0	0.0	0.0	0.0	0.0	0.0
	Wolf Lands 3	0.0	0.0	0.0	0.3	2,745.6	9.9
	Wolf Lands 4	0.0	0.0	0.0	1.1	11,932.8	29.5
Tract 4		0.0	0.0	0.0	0.0	0.0	0.0
Tract 5		0.0	900.0	32.1	0.0	0.0	0.0
Subtotal: Non-federal lands		141.5	18,000.0	35.6	9.6	88,070.4	54.3
Net Change							
Net Increase/(Decrease)		111.0	13,450.0	34.9	4.5	34,214.4	46.0

Source: Data from Section 4.3.3.

5.3.3.2 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing wetland resources, floodplains, and surface waters on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change USFS's responsibility for managing wetland resources, floodplains, and surface waters and would result in no further effects on these resources.

5.3.3.3 Land Exchange Alternative B

5.3.3.3.1 Wetlands and Floodplains

The smaller federal parcel contains approximately 2,861 acres of wetlands (see Table 5.3.3-7). By comparison, the non-federal lands contain approximately 2,931 acres of wetlands. The Land Exchange Alternative B would result in a net increase of 69.8 acres of wetlands to the federal estate. The Land Exchange Alternative B would increase wetland areas by 69.8 acres through the acquisition of up to 4,926.3 acres of the non-federal lands in exchange for 4,752.6 acres of federal land, and would thus be in conformity with EO 11190. The Land Exchange Alternative B would result in a net decrease of 1,036.7 acres of floodplains; however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain, no increase in the flood damage potential, and the ecological function of the floodplain would not change; therefore, the Land Exchange Alternative B would be in conformance with EO 11988.

Table 5.3.3-7 Wetland and Floodplain Acres for Land Exchange Alternative B

	Acres of Wetlands	Acres of Floodplains
Lands Conveyed		
Smaller Federal Parcel	2,861.0	1,412.9
Lands Acquired		
Tract 1	2,930.8	376.2
Net Change		
Net Increase/(Decrease)	69.8	(1,036.7)

As part of the increase in wetland acreage, Land Exchange Alternative B would result in a net increase to the federal estate of the following wetland resource types (Table 5.3.3-8): coniferous swamp (1,477.8 acres), open water (168.0 acres), and shrub swamp (311.4 acres). However, the Land Exchange Alternative B would result in a net decrease to the federal estate of the following wetland resource types: coniferous bog (1,677.0 acres), hardwood swamp (5.7 acres), open bog (88.8 acres), sedge/wet meadow (34.9 acres), and shallow marsh (80.9 acres).

Table 5.3.3-8 Wetland Resource Types for Land Exchange Alternative B

Parcel	Acres of Wetland Resource Types								
	Coniferous Bog	Coniferous Swamp	Deep Marsh	Hardwood Swamp	Open Bog	Open Water (includes shallow, open water, and lakes)	Sedge/Wet Meadow	Shallow Marsh	Shrub Swamp (includes alder thicket and shrub-carr)
Lands Conveyed									
Smaller Federal Parcel	1,677.0	476.1	0	13.7	175.0	8.6	34.9	80.9	394.7
Lands Acquired									
Tract 1	0	1,953.9	0	8.0	86.2	176.6	0	0	706.1
Net Change									
Net Increase/(Decrease)	(1,677.0)	1,477.8	0.0	(5.7)	(88.8)	168.0	(34.9)	(80.9)	311.4

5.3.3.3.2 Wetland Functional Assessment

The Land Exchange Alternative B would result in an increase of wetlands rated as high for vegetation diversity/integrity, hydrology, wetland water quality, wildlife habitat, fish habitat, and amphibian habitat. There would be a decrease of wetlands rated high and moderate for flood attenuation and downstream water quality. The Land Exchange Alternative B would also result in an increase of wetlands rated low for amphibian habitat. The Land Exchange Alternative B would not result in a change to aesthetics/education/cultural functions.

5.3.3.3.3 Frontage of Waterways

The Land Exchange Alternative B would result in a net increase of other water resources to the federal estate (Table 5.3.3-9). A net increase of approximately 133 acres of lake and 3.1 miles of rivers will be added to the federal estate from the Land Exchange Alternative B. These increases would result in additional frontage of lakes and rivers to the federal estate.

Table 5.3.3-9 Frontage of Waterways for Land Exchange Alternative B

	Lake			Rivers/Creeks/Streams		
Parcel	**Acres**	**Frontage (ft)**	**Length of Lake Frontage/Acre**	**Miles**	**Frontage (linear ft)**	**Length of River Frontage/Acre**
Lands Conveyed						
Smaller Federal Parcel	8.9	1,200.0	0.3	5.1	53,856.0	11.3
Lands Acquired						
Tract 1	141.5	17,100.0	3.5	8.2	73,392.0	14.9
Net Change						
Net Increase/(Decrease)	132.6	15,900.0	3.2	3.1	19,536.0	3.6

Source: Data from Section 4.3.3.

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5.3.4 Vegetation

This section provides an evaluation of the effects of the Land Exchange Proposed Action on vegetation, including comparisons of MDNR GAP land cover types, native plant community types, MBS Sites of Biodiversity Significance, MIH types, age classes, threatened and endangered plant species, and biodiversity between the federal and non-federal lands. Table 5.3.4-1 provides a summary of these data on a net increase or decrease basis.

When comparing the total acres of the federal and non-federal lands, the federal estate would have an increase of 579.6 acres of MDNR GAP land cover types (Table 5.3.4-1) as a result of the Land Exchange Proposed Action. The shrublands (1,199.4 acres) would increase the most and the upland conifer forests (919.5 acres) would decrease the most (Table 5.3.4-2). There would be an acreage increase of lowland black spruce-tamarack forest (MIH 9) with lesser amounts of upland forest (MIH 1) and aquatic habitat (MIH 14), but a decrease of upland conifer forest (MIH 5) (Table 5.3.4-1). There would be an increase to National Forest System lands of immature forest stands with lesser amounts of young stands, but a decrease in mature forest stands.

There would be a decrease to the federal estate of up to approximately 6,026 acres of MBS Sites of High Biodiversity Significance and an increase of up to approximately 768 acres of MBS Sites of Moderate Biodiversity Significance under the Land Exchange Proposed Action (Table 5.3.4-1). There would be a decrease to the federal estate of three native plant communities that are “imperiled,” “imperiled-vulnerable,” or “vulnerable,” as well as others that are ranked as “apparently secure” or “widespread and secure,” in exchange for one native plant community that is ranked as “vulnerable” and two that are ranked as “apparently secure.” There would be a decrease to the federal estate of up to 2,016.6 acres in the Jack Pine-Black Spruce landscape ecosystem, and an increase of up to 994.7 acres in the Lowland Conifer landscape ecosystem and 558.7 acres in the Mesic Red and White Pine landscape ecosystem. Additionally, the USFS would increase representation in the Dry-Mesic Red and White Pine, Mesic Birch-Aspen-Spruce-Fir, Lowland Hardwood, and Sugar Maple landscape ecosystems. Overall, there would be an increase of approximately 625 acres of landscape ecosystems as a result of the Land Exchange Proposed Action.

There would be a decrease to the federal estate of 13 populations of 11 state-listed ETSC plant species on the federal lands in exchange for two populations of two known state-listed ETSC plant species on the non-federal lands. Though the 11 state-listed plant species on the federal lands are not known to occur on the non-federal lands, the Land Exchange Proposed Action would result in an increase of most habitats important to them. Drawing from the MIH exchange, RFSS plants associated with upland forest (MIH 1), lowland black spruce-tamarack forest (MIH 9), and aquatic habitat (MIH 14) could potentially exist on or spread to the habitats on the non-federal parcels.

Table 5.3.4-1 Vegetation and Cover Type Increase or Decrease to the Federal Estate Due to Land Exchange Proposed Action

Category		Net Increase/(Decrease) Land Exchange Proposed Action	Land Exchange No Action Alternative	Alternative B
Habitat Types (acres)	MDNR GAP Land Cover Types	579.6	0	173.6
	MIH 1 (Upland Forest)	110.7	0	273.0
	MIH 5 (Upland Conifer Forest)	(1,172.5)	0	(1,084.6)
	MIH 9 (Lowland Black Spruce-tamarack Forest)	737.9	0	(261.2)
	MIH 14 (Aquatic Habitat)	226.7	0	206.2
	Lowland Shrub	(162.6)	0	(273.4)
	Lowland Emergent	185.6	0	249.6
	Upland Grass	43.3	0	0
	Young Forest Stands	507.1	0	262.7
	Immature Forest Stands	2,000.3	0	1,933.9
	Mature Forest Stands	(2,049.1)	0	(2,126.8)
MBS Sites (acres)	High Biodiversity Sites	(6,025.8)	0	(4,573.1)
	Moderate Biodiversity Sites	767.9	0	(0.3)
Native Plant Communities	Imperiled (S2)	(1)	0	0
	Imperiled/Vulnerable (S2-3)	(1)	0	(1)
	Vulnerable (S3)	(1) and +1 other	0	(1)
	Apparently Secure (S4)	(6) and +2 others	0	(2)
	Widespread and Secure (S5)	(6)	0	(4)
Landscape Ecosystems (acres)	Dry-Mesic Red and White Pine	683.0	0	589.2
	Jack Pine-black Spruce	(2,016.6)	0	(1,411.6)
	Lowland Conifer	994.7	0	486.2
	Lowland Hardwood	66.5	0	0
	Mesic Birch-aspen-spruce-fir	302.2	0	0.9
	Mesic Red and White Pine	558.7	0	528.0
	Sugar Maple	36.7	0	0
ETSC Species (number of species)	State-listed Plant Species	(11) species +2 different species	0	(11) species
Management Area (acres)	General Forest	5,714.1	0	4,264.0
	General Forest – Longer Rotation	(5,658.0)	0	(4,397.3)
	cRNA	306.9	0	306.9
	Riparian Emphasis Area	220.9	0	0

5.3.4.1 Methodology and Evaluation Criteria

The vegetation assessment area for the Land Exchange Proposed Action would involve approximately 6,495.4 acres of federal lands transferred from public to private ownership, and up to approximately 7,075.0 acres of land transferred from private to public ownership. The spatial and temporal area of analysis for vegetation as part of the Land Exchange Proposed Action included direct and indirect effects resulting from the change in ownership of the federal and non-federal lands, including the extent of landscape ecosystems as defined in the Forest Plan or the extent of similar landscape ecosystems on the abutting forest lands.

An evaluation was conducted to determine the potential effect that the Land Exchange Proposed Action would have on the following vegetation resources:

- the quality and quantity of forest resources/lands (change in forest types and age classes);
- change in state-listed ETSC plant species and RFSS plants (individuals, habitat, and/or populations);
- change in biodiversity or overall vegetation and habitat; and
- the introduction and spread of invasive non-native species.

The analysis of the vegetation resources affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies, which included a comparison of the MDNR GAP land cover types, native plant communities, MBS Sites of Biodiversity Significance, MIH types (MIH 1, 5, 9, and 14, as well as lowland shrublands, lowland emergent wetlands, and upland grass), age classes (young, immature, and mature), large mature forest patches, landscape ecosystems, management areas, threatened and endangered plant species, RFSS plants, and invasive non-native plant species. GIS data for these categories were gathered to the extent possible, and then compared over an area of analysis that included the federal and non-federal lands, and also the surrounding landscape ecosystems of the Superior National Forest or ecological subsections. MIH types and age classes have also been compared within the context of landscape ecosystems to reveal how many acres of each MIH and age class would be increased or decreased by the Land Exchange Proposed Action within each landscape ecosystem. MIH type and age class data for the non-federal lands were interpreted from field survey maps, aerial maps, surrounding federal MIH data, topographic maps, and USFS review. These were then compared to the federal lands MIH data to determine MIH type and age class increases or decreases of acreage. Additionally, all of the data types mentioned have been compared to summarize the vegetative biodiversity of the federal and non-federal lands.

5.3.4.2 Land Exchange Proposed Action

5.3.4.2.1 Cover Types

Cover types consist of several categories of classification, including MDNR GAP land cover types, USFS management areas, USFS ELTs, and USFS MIH types.

Habitat Types

The Land Exchange Proposed Action would result in an increase to the federal estate of up to 579.6 acres of MDNR GAP land cover designations, with the greatest increase in shrubland acreage of 1,199.4 acres and the greatest decrease in upland conifer forest of 919.5 acres (Table 5.3.4-2). The decrease of upland conifer forest is contrary to a goal of the 2004 Forest Plan. The Forest Plan calls for an increase in the acreage of red, white, and jack pine habitats (and a decrease in the acreage of aspen vegetation communities). In addition, the Land Exchange Proposed Action would support other Forest Plan goals to maintain acreage of lowland deciduous habitats and non-forested wetlands. The Land Exchange Proposed Action would result in a small increase of lowland deciduous forests, an increase in aquatic habitats, and a large increase of shrublands.

Table 5.3.4-2 Net Increase or Decrease to the Federal Estate of MDNR GAP Land Cover Types under the Land Exchange Proposed Action

Cover Types	Federal Land Acres	Non-federal Land Acres	Net Increase/ (Decrease) Acres
Shrubland	645.6	1,845.0	1,199.4
Aquatic environments	60.1	266.6	206.5
Upland deciduous forest	1,091.8	1,232.9	141.1
Upland conifer-deciduous mixed forest	20.9	50.4	29.5
Cropland/grassland	6.2	31.7	25.5
Lowland deciduous forest	9.5	28.6	19.1
Lowland coniferous forest	2,978.6	2,920.5	(58.1)
Disturbed	63.8	0.0	(63.8)
Upland coniferous forest	1,618.9	699.4	(919.5)
Total [1]	6,495.4	7,075.0	579.6

Source: MDNR 2006b.

[1] Total acres may be more or less than presented due to rounding.

Culturally Important Plants

The Land Exchange Proposed Action would result in additional wild rice beds by the acquisition of Tract 1. Tract 1 contains Little Rice Lake, which supports a continuous population of wild rice. Wild rice also grows along the Pike River south of Little Rice Lake and in isolated populations on Hay Lake. Section 4.3.4.2.1 provides further discussion of wild rice on Tract 1. Wild rice does not currently grow within the proposed federal land boundaries. As a result, the public would have more opportunities for wild rice harvesting on Tract 1, where there is currently no opportunity to harvest wild rice directly on the federal lands. A carry-down boat launching access is located on Tract 1, which may provide private access for wild rice harvesting on the Tract 1 lands. Access to wild rice beds on the federal lands would not be lost as a result of the Land Exchange Proposed Action, but access to wild rice beds on Tract 1 would be gained.

Natural resources culturally important to the Bands are discussed in Section 4.2.9.

Minnesota Biological Survey

The Land Exchange Proposed Action would result in a decrease to the federal estate of 6,142.7 acres of MBS Sites of High Biodiversity Significance in the Laurentian Uplands subsection, and an increase of 116.9 acres of MBS Sites of High Biodiversity Significance in the North Shore Highlands subsection. Furthermore, the Land Exchange Proposed Action would result in an increase of 767.6 acres of MBS Sites of Moderate Biodiversity Significance in the Laurentian Uplands subsection.

Native plant community rankings are largely unavailable for the non-federal lands, with the exception of Lake County South, which has one site ranked as "vulnerable" and others ranked as "apparently secure." Section 4.3.4.2.2 provides further discussion of native plant community types on the Lake County South parcel. The Land Exchange Proposed Action would result in a decrease to the federal estate of three native plant communities on the federal lands that are ranked as "imperiled" to "vulnerable" in the state. A native plant community increase or decrease comparison cannot be accurately made since rankings are unavailable for much of the non-federal lands.

Management Areas

The USFS manages its forests by assigning various management area allocations, which are determined based on existing vegetation communities. The federal lands are currently managed under the General Forest – Longer Rotation Management Area (94 percent) and the General Forest Management Area (6 percent) (Table 5.3.4-3). The majority of the non-federal lands (86 percent) would be allocated to the General Forest Management Area upon completion of the Land Exchange Proposed Action. This management area provides a wide variety of goods, uses, and services, including wood products, scenic quality, recreation opportunities, and habitat types (USFS 2004b). The remaining non-federal lands would be allocated to the General Forest – Longer Rotation Management Area (7 percent), Potential/cRNA (4 percent), and Riparian Areas Management Area (3 percent). Section 5.3.1 provides a discussion of management areas on the non-federal lands for the Land Exchange Proposed Action.

Through the acquisition of Tract 1, the Land Exchange Proposed Action would result in a gain of a large contiguous block of land and lakeshore/river frontage. The majority of this tract (94 percent) would be allocated to the General Forest Management Area, with the balance allocated as a cRNA (6 percent). Two cRNA lands abut Tract 1 (USFS 2011b) and, upon completion of the Land Exchange Proposed Action, these two cRNA lands would be extended onto the parcel. The Pike Mountain cRNA is located at the southwestern corner of Tract 1. Approximately 135 acres of Tract 1 are proposed to be added to the Pike Mountain cRNA because it is an extension of the northern hardwood uplands with a high sugar maple component. The Loka Lake cRNA is located at the northeastern corner of Tract 1. Approximately 172 acres of the parcel are proposed to be added to the Loka Lake cRNA because it is an extension of the high-quality lowland black spruce and tamarack swamp.

The Land Exchange Proposed Action would result in Tract 2 being allocated as Riparian Areas (83 percent) and General Forest – Longer Rotation Management Area (17 percent) (USFS 2011b). The Riparian Emphasis Area Management Area provides protection to diverse age classes, but generally for older-growth forest stands along sensitive riparian areas.

The majority of Tract 3 would be allocated to the General Forest Management Area (92 percent), with the remaining 8 percent allocated to the General Forest – Longer Rotation Management Area (USFS 2011b).

All of Tracts 4 and 5 would be allocated to the General Forest – Longer Rotation Management Area (USFS 2011b). Obtaining Tract 5 would result in a gain of lakeshore property.

Overall, there would be a large increase to the federal estate in the General Forest Management Area (5,714.1 acres) and smaller increases in the cRNA (306.9 acres) and Riparian Areas (220.9 acres) Management Areas as a result of the Land Exchange Proposed Action (Table 5.3.4-3). There would be a decrease of 5,658 acres of the General Forest – Longer Rotation Management Area. The lands to be acquired as part of the Land Exchange Proposed Action would be managed in accordance with Forest Plan standards and guidelines.

Table 5.3.4-3 Net Increase or Decrease to the Federal Estate of Management Areas under the Land Exchange Proposed Action

	Federal Lands		Non-federal Lands		Net Increase/ (Decrease)
Category	**Acres**	**%**	**Acres**	**%**	**Acres**
General Forest	355.3	6	6,069.4	86	5,714.1
General Forest – Longer Rotation	6,135.8	94	477.8	7	(5,658.0)
Potential/cRNAs	0.0	0	306.9	4	306.9
Riparian Areas	0.0	0	220.9	3	220.9

Source: USFS 2011j.

Ecological Land Types

The Land Exchange Proposed Action would result in an increase of seven ELTs, including ELT 3, 4, 10, 11, 14, 17, and 18. Five of these ELTs are upland soils and two are lowland soils. The USFS would not lose representation of any ELTs currently on the federal lands, based on available data.

Management Indicator Habitats

The Land Exchange Proposed Action would result in an increase to the federal estate of lowland black spruce-tamarack forest (MIH 9; 737.9 acres), aquatic habitat (MIH 14; 226.7 acres), and upland forest (MIH 1; 110.7 acres), and a decrease of upland conifer forest (MIH 5; 1,172.5 acres) (Table 5.3.4-4). The Land Exchange Proposed Action would also result in a decrease to the federal estate of lowland shrub habitat (162.6 acres), but an increase in lowland emergent (185.6 acres) and upland grass (43.3 acres) habitat types. While not considered MIH types, these are important habitats for several wildlife species. The fact that aquatic habitat (MIH 14) is not mapped on the federal lands results in an apparent increase in these categories, even though this habitat type does occur on the federal lands.

The Land Exchange Proposed Action would result in an increase to the federal estate of 2,507.4 acres of young and immature forest stands. However, it would result in a decrease of 2,049.1 acres of mature forest types. In addition, the Land Exchange Proposed Action would result in a decrease to the federal estate of approximately 1,095 acres of large mature forest patches (stands over 300 acres).

Table 5.3.4-4 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes under the Land Exchange Proposed Action

Category	Federal Land Acres [2]	Non-federal Land Acres [1,2]	Net Increase/ (Decrease) Acres
MIH Types			
MIH 1 (Upland Forest)	2,583.8	2,694.5	110.7
MIH 5 (Upland Conifer Forest)	1,252.4	79.9	(1,172.5)
MIH 9 (Lowland Black Spruce-tamarack Forest)	2,582.7	3,320.6	737.9
MIH 14 (Aquatic Habitat)	0.0	226.7	226.7
Lowland Shrub	493.5	330.9	(162.6)
Lowland Emergent	200.1	385.7	185.6
Upland Grass	0.0	43.3	43.3
Age Classes			
Young	271.1	778.2	507.1
Immature	1,539.4	3,539.7	2,000.3
Mature	3,873.7	1,824.6	(2,049.1)

Source: USFS 2010b.

1 According to non-federal lands cover type table (Table 4.3.4-3).
2 Total acres may be more or less than presented due to rounding.

Landscape Ecosystems

The Land Exchange Proposed Action would result in a decrease to the federal estate of 2,016.6 acres of the Jack Pine-Black Spruce landscape ecosystem, but there would be an increase of 994.7 acres in the Lowland Conifer landscape ecosystem and 558.7 acres of the Mesic Red and White Pine landscape ecosystem. The Superior National Forest, as part of the Land Exchange Proposed Action, would have increased representation in the Dry-Mesic Red and White Pine landscape ecosystem (682.9 acres), Mesic Birch-Aspen-Spruce-Fir landscape ecosystem (302.2 acres), Lowland Hardwood landscape ecosystem (66.5 acres), and the Sugar Maple landscape ecosystem (36.7 acres), and there would be an overall increase of 625.1 acres.

Within the Superior National Forest, the USFS tracks acreage of MIH types and age classes within each landscape ecosystem to better manage them within the broader ecological context. As a result of the Land Exchange Proposed Action, there would be an increase to the federal estate in acreage of MIH types and age classes within some landscape ecosystems and a decrease in others (Table 5.3.4-5). The greatest percentage increase in MIH acreage within a landscape ecosystem is lowland black spruce-tamarack forest (MIH 9) in the Mesic Birch-Aspen-Spruce-Fir landscape ecosystem, while the greatest decrease is upland conifer forest (MIH 5) in the Jack Pine-Black Spruce landscape ecosystem. The greatest percentage increase in age class acreage within a landscape ecosystem is the immature age class in the Lowland Conifer landscape ecosystem, while the greatest decrease is the immature and mature age classes in the Jack Pine-Black Spruce landscape ecosystem. Overall, the Lowland Conifer landscape ecosystem would have the highest acreage increase in MIH types and age classes, while the Jack Pine-Black Spruce landscape ecosystem would have the highest acreage decrease in MIH types and age classes.

Table 5.3.4-5 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes within Landscape Ecosystems in the Superior National Forest under the Land Exchange Proposed Action

Landscape Ecosystem Name			Dry-Mesic Red and White Pine	Jack Pine-Black Spruce	Lowland Conifer	Lowland Hardwood	Mesic Birch-Aspen-Spruce-Fir	Mesic Red and White Pine	Sugar Maple
Category			**Net Increase/(Decrease)**						
MIH Types	MIH 1	Acres[1]	517.0	(1,374.7)	289.0	10.1	140.8	527.1	1.1
		% [2]	2	(4)	2	2	0	1	1
	MIH 5	Acres	15.5	(1,089.3)	(121.2)	3.2	7.6	11.6	0
		%	0	(8)	(2)	2	0	0	0
	MIH 9	Acres	26.2	(390.7)	928.9	17.1	134.7	13.8	7.8
		%	1	(7)	2	1	4	0	0
	MIH 14	Acres	115.5	2.2	97.8	9.1	0.3	0.8	0.9
		% [3]	NA	NA	NA	NA	NA	NA	NA
Lowland Shrub		Acres	3.0	(95.0)	(113.0)	24.0	19.0	0	0
		%	0	(4)	(1)	4	1	0	0
Lowland Emergent		Acres	6.0	(62.3)	348.1	3.2	0	2.4	3.1
		%	1	(7)	5	1	0	0	0
Upland Grass		Acres	0	(0.2)	15.4	0	0	0	23.6
		%	0	0	5	0	0	0	0
Age Classes	Young	Acres	250.8	(21.5)	188.0	5.6	51.1	9.3	23.6
		%	15	(1)	18	7	2	0	0
	Immature	Acres	178.7	(700.3)	2,170.2	2.3	50.4	298.9	0
		%	1	(4)	28	1	0	1	0
	Mature	Acres	129.2	(1,079.0)	(1,559.6)	22.5	181.6	247.1	8.9
		%	1	(4)	(2)	1	1	1	6

Source: USFS 2010b; USFS 2011g.

[1] Total acres may be more or less than presented due to rounding.
[2] Percentage of acres increased or decreased within the entire landscape ecosystem in the Superior National Forest.
[3] MIH 14 is not tracked on the federal lands; thus, percentage is NA (not applicable).

5.3.4.2.2 Invasive Non-native Plants

The Land Exchange Proposed Action would result in a reduction of occurrences of invasive non-native species on the federal lands, but an increase of similar occurrences of invasive non-native species on Tracts 1, 2, and 3, including common tansy, orange hawkweed, ox-eye daisy, and thistles. Tracts 4 and 5 would not see an increase of any occurrences of invasive non-native species.

5.3.4.2.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

There are fewer occurrences of state-listed ETSC plant species on the non-federal lands (two species on Tract 5) than on the federal lands (11 species), so the USFS would have fewer populations as a result of the Land Exchange Proposed Action (Table 5.3.4-6). The two species gained in the exchange are *Woodsia scopulina* and *Saxifraga paniculata*. Section 4.3.4.2.5

provides a discussion of these species. There are no federally listed plant species in St. Louis, Lake, or Cook counties (USFWS 2012).

Though the 11 known state-listed ETSC plant species on the federal lands are not known to occur on the non-federal lands, the Land Exchange Proposed Action would result in an increase of most habitats important to them. The Land Exchange Proposed Action would result in additional grassland habitat, which *Botrychium campestre* and *Botrychium pallidum* occupy. The Land Exchange Proposed Action would also result in an increase of upland deciduous and mixed forest habitats, used by *Botrychium pallidum*, *Botrychium rugulosum*, and *Botrychium simplex*. There would be an increase of aquatic habitats (open water or wetlands) for *Caltha natans*, *Eleocharis nitida*, *Juncus stygius* var. *americanus*, *Spaganium glomeratum*, and *Torreyochloa pallida*. According to the MIH analysis, the Land Exchange Proposed Action would result in an increase of lowland black spruce or tamarack habitats, which could mean more habitats for *Platanthera clavellata*, *Pyrola minor*, and *Ranunculus lapponicus*.

Table 5.3.4-6 Increase or Decrease to the Federal Estate of State-listed ETSC Plant Populations under the Land Exchange Proposed Action

	Federal Lands Populations		Non-federal Lands Populations		
Plant Species (State Status/ Global Status[1])	**Total Populations[2,3]**	**Total Individuals[3]**	**Total Populations[2,3]**	**Total Individuals[3]**	**Net Species Increase/ (Decrease)**
Botrychium pallidum (E/G3)	1	2	0	NA	(1)
Botrychium rugulosum (T/G3)	1	4	0	NA	(1)
Botrychium simplex (SC/G5)	3	905	0	NA	(1)
Caltha natans (E/G5)	1	29	0	NA	(1)
Eleocharis nitida (T/G4)	1	~486 ft^2	0	NA	(1)
Juncus stygius var. *americanus* (SC/G5)	1	1	0	NA	(1)
Platanthera clavellata (SC/G5)	1	5	0	NA	(1)
Pyrola minor (SC/G5)	1	10	0	NA	(1)
Ranunculus lapponicus (SC/G5)	1	~919 ft^2	0	NA	(1)
Sparganium glomeratum (SC/G4)	1	28	0	NA	(1)
Torreyochloa pallida (SC/G5)	1	~25 ft^2	0	NA	(1)
Woodsia scopulina (T/G5)	0	NA	1	2	1
Saxifraga paniculata (T/G5)	0	NA	1	1,000	1
Total	13	NA	2	NA	(9)

Source: MDNR 2013a.

[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 2011).

[2] Populations are interpreted from MDNR NHIS data using Element Occurrence; this differs from the DEIS, which used colonies as the population estimate.

[3] Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Regional Foresters Sensitive Species

The USFS RFSS data layer indicates there are no RFSS plants on the federal lands. However, several state-listed ETSC plant species that occur on the federal lands are also listed as RFSS plants, including *Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, *Juncus stygius* var. *americanus*, and *Pyrola minor*. The USFS would have a decrease in these RFSS plant species as a result of the Land Exchange Proposed Action. *Saxifraga paniculata* is a state-listed ETSC plant species that is also listed as a RFSS plant on the Tract 5 lands. The USFS would gain this RFSS plant species under the Land Exchange Proposed Action.

There would be the greatest increase to the federal estate in acres of lowland black spruce-tamarack forest (MIH 9; Table 5.3.4-4) as a result of the Land Exchange Proposed Action, which means there is the highest chance to gain the RFSS plants listed under that category in Table 4.2.4-5. There would be smaller acreage increases of both upland forest (MIH 1) and aquatic habitat (MIH 14), meaning the RFSS plants in those categories could also be gained. The largest acreage decrease would be upland conifer forest (MIH 5). There are no RFSS plants specifically listed under upland conifer forest (MIH 5); however, it is likely that some RFSS plants that occupy upland forest (MIH 1) habitats would also occupy upland conifer forest (MIH 5) habitats and the USFS could therefore have a decrease in RFSS plant species that prefer coniferous upland habitats.

5.3.4.2.4 Biodiversity

Biodiversity is described in the Forest Plan as the “variety of life and its ecological processes … [as well as] ecosystems, which comprise both the communities of organisms within particular habitats, and the physical conditions under which they live” (USFS 2004b). Biodiversity is important to consider for managing natural communities in a sustainable and ecological manner. Several data sources mentioned above and in Section 4.2.4 were compared on an increase or decrease basis to measure or estimate the biodiversity of both the federal and non-federal lands.

The federal land contains a high level of biodiversity because the majority of the parcel has been classified for inclusion in two Sites of High Biodiversity Significance. Additionally, several different native plant communities exist on it, as do 11 state-listed ETSC plant species. Because the non-federal lands have not been fully studied yet, they contain less biodiversity classification since they lack MBS Sites of High Biodiversity Significance and native plant communities. Table 5.3.4-1 provides a summary of the various data used to estimate biodiversity.

In summary, the non-federal lands contain 116.9 acres of MBS Sites of High Biodiversity Significance in the North Shore Highlands subsection and 767.9 acres of MBS Sites of Moderate Biodiversity Significance in the Laurentian Uplands subsection. The Land Exchange Proposed Action would result in a decrease to the federal estate of 6,142.7 acres of MBS Sites of High Biodiversity Significance in the Laurentian Uplands subsection, and an increase of 116.9 acres of MBS Sites of High Biodiversity Significance in the North Shore Highlands subsection. Furthermore, the Land Exchange Proposed Action would result in an increase of 767.6 acres of MBS Sites of Moderate Biodiversity Significance in the Laurentian Uplands subsection. Overall, there would be a decrease of 6,025.8 acres of MBS Sites of High Biodiversity Significance and an increase of 767.6 acres of MBS Sites of Moderate Biodiversity Significance under the Land Exchange Proposed Action. However, several of the non-federal lands have preliminary classifications of Sites as Moderate, High, or Outstanding Biodiversity Significance, which, if approved by the MDNR MBS program, would help balance the exchange.

Native plant community rankings are largely unavailable for the non-federal lands, with the exception of Lake County South, which has one site ranked as "vulnerable" and others ranked as "apparently secure." Section 4.3.4.2.2 provides further discussion of native plant community types on the Lake County South parcel. The Land Exchange Proposed Action would result in a decrease to the federal estate of three native plant communities on the federal lands that are ranked as "imperiled" to "vulnerable" in the state. A native plant community increase or decrease comparison cannot be accurately made since rankings are unavailable for much of the non-federal lands.

Endangered, Threatened, and Special Concern Plant Species

As previously stated, the federal lands support 11 known state-listed ETSC plant species, while the non-federal lands currently support two known state-listed ETSC plant species. This would be a decrease to the federal estate in known state-listed species as a result of the Land Exchange Proposed Action.

5.3.4.3 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing vegetation resources on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the Forest Service's responsibility for managing vegetation resources and would result in no further effects on existing vegetation.

5.3.4.3.1 Cover Types

Under the Land Exchange No Action Alternative, the current federal lands would remain in federal ownership and the lands would continue to be managed under the General Forest – Longer Rotation Management Area and the General Forest Management Area. Direct and indirect effects of the Land Exchange No Action Alternative on cover types would be unchanged, as the management of these forests has occurred on site in the past. None of the federal lands currently have any vegetation management actions planned in the near future, regardless of whether the Land Exchange Proposed Action were to occur.

5.3.4.3.2 Invasive Non-native Plants

Non-native species may still invade the federal lands as a result of logging, mineral exploration, vehicle traffic, and natural disturbances, but are likely to do so much more slowly than they would under the Land Exchange Proposed Action. The proximity of the federal lands to the already-disturbed Plant Site may put the federal lands at risk of eventual colonization by invasive non-native species.

5.3.4.3.3 Threatened and Endangered Plant Species

Under the Land Exchange No Action Alternative, timber harvests are expected to continue to occur on the federal lands, though there are not any planned in the near future. Effects on ETSC plant species and RFSS plants, for different management techniques, are addressed in the Forest Plan (USFS 2004b).

5.3.4.3.4 Biodiversity

The Land Exchange No Action Alternative would not result in any change to biodiversity on the federal lands.

5.3.4.4 Land Exchange Alternative B

5.3.4.4.1 Cover Types

The effects of Land Exchange Alternative B would be comparable to those from the Land Exchange Proposed Action, although to a lesser extent. A smaller portion of the federal lands (approximately 4,752.6 acres) would be transferred into private ownership for the non-federal Tract 1 lands (approximately 4,926.3 acres), which would be conveyed into USFS ownership. Under this alternative, the USFS would retain a smaller federal parcel located on the northwestern and western sides of the current federal lands, which would create additional linear boundaries for the USFS to maintain (see Section 5.3.1).

Habitat Types

This alternative would result in an overall increase of 173.6 acres of MDNR GAP land cover types. As under the Land Exchange Proposed Action, the greatest increase to the federal estate would be shrubland acreage (1,227.7 acres), and upland conifer forest would have the greatest acreage decrease (928.8 acres), as shown in Table 5.3.4-7 below.

Table 5.3.4-7 Net Increase or Decrease to the Federal Estate of MDNR GAP Land Cover Types under Land Exchange Alternative B

Cover Types	Alternative B: Smaller Federal Parcel Acres	Tract 1 Acres [1]	Net Increase/ (Decrease) Acres
Shrubland	436.9	1,664.6	1,227.7
Aquatic environments	26.3	251.1	224.8
Upland deciduous forest	804.7	999.9	195.2
Cropland/grassland	2.2	31.7	29.5
Lowland deciduous forest	4.7	17.4	12.7
Upland conifer-deciduous mixed forest	17.8	0.0	(17.8)
Disturbed	29.1	0.0	(29.1)
Lowland coniferous forest	2,064.8	1,524.2	(540.6)
Upland coniferous forest	1,366.1	437.3	(928.8)
Total [2]	4,752.6	4,926.2	173.6

Source: MDNR 2006b.

1 According to Tract 1 land cover type table (Table 4.3.4-12).
2 Total acres may be more or less than presented due to rounding.

Culturally Important Plants

As with the Land Exchange Proposed Action, Land Exchange Alternative B would result in additional wild rice beds from the acquisition of Tract 1. Section 5.3.4.2 provides additional information on wild rice.

As with the Land Exchange Proposed Action, see Section 4.2.9 for a discussion of natural resources culturally important to the Bands.

Minnesota Biological Survey

Land Exchange Alternative B would result in a decrease to the federal estate of 4,573.1 acres of MBS Sites of High Biodiversity Significance and a decrease of 0.3 acre of MBS Sites of Moderate Biodiversity Significance within the Laurentian Uplands subsection (Table 5.3.4-1). Portions of the west end of One Hundred Mile Swamp would remain in federal ownership. Furthermore, Land Exchange Alternative B would result in removal from the Superior National Forest of three native plant communities that are ranked as "imperiled" to "vulnerable" in the state. As previously discussed, Tract 1 does not contain any MBS Sites of Biodiversity Significance or native plant communities, so, unlike the Land Exchange Proposed Action, the federal estate would not have an increase of either MBS sites or native plant communities under this alternative.

Management Areas

Lands included as part of Land Exchange Alternative B are currently managed under the General Forest – Longer Rotation Management Area (93 percent) and the General Forest Management Area (7 percent) (Table 5.3.4-8). The majority of Tract 1 (94 percent) would be allocated to the General Forest Management Area upon completion of Land Exchange Alternative B, and the remaining area would be managed under the cRNA Management Area (6 percent). Land Exchange Alternative B would be comparable to the Land Exchange Proposed Action in that cRNA lands would be increased, but Riparian Areas would not be.

Table 5.3.4-8 Net Increase or Decrease to the Federal Estate of Management Areas under Land Exchange Alternative B

	Land Exchange Alternative B		Tract 1		Net Increase/ (Decrease)
Category	**Acres**	**%**	**Acres**	**%**	**Acres**
General Forest	355.3	7	4,619.3	94	4,264.0
General Forest - Longer Rotation	4,397.3	93	0.0	0	(4,397.3)
Potential/candidate Research Natural Areas	0.0	0	306.9	6	306.9
Riparian Areas	0.0	0	0.0	0	0

Source: USFS 2011j.

Ecological Land Types

Land Exchange Alternative B would result in a decrease to the federal estate of five ELTs, including ELT 1, 2, 6, 13, and 16, which are currently located on the proposed smaller federal parcel. The ELTs are unavailable for Tract 1, and so a comparison cannot be made.

Management Indicator Habitats

Land Exchange Alternative B would result in an increase to the federal estate in upland forest (MIH 1; 273.0 acres) and aquatic habitat (MIH 14; 206.2 acres); however, there would be a decrease of upland conifer forest (MIH 5; 1,084.6 acres) and lowland black spruce-tamarack forest (MIH 9; 261.2 acres) (Table 5.3.4-9). Though not considered MIH types, there would be a decrease to the federal estate of lowland shrubland habitat (273.4 acres) and an increase of lowland emergent wetlands (249.6 acres). Similar to the Land Exchange Proposed Action, the aquatic habitat (MIH 14) type is not fully mapped on lands that are part of Land Exchange Alternative B, resulting in an apparent increase in this category; however, this habitat type does occur on these lands.

There would be a large increase to the federal estate of immature forest stands (1,933.9 acres) with lesser amounts of young stands (262.7 acres), corresponding to a decrease of mature forest stands (2,126.8 acres).

Table 5.3.4-9 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes under Land Exchange Alternative B

Category	Land Exchange Alternative B [2]	Tract 1 Acres [1,2]	Net Increase/ (Decrease) Acres
MIH Types			
MIH 1 (Upland Forest)	2,093.0	2,366.0	273.0
MIH 5 (Upland Conifer Forest)	1,138.8	54.2	(1,084.6)
MIH 9 (Lowland Black Spruce-tamarack Forest)	2,090.9	1,829.7	(261.2)
MIH 14 (Aquatic Habitats)	0.0	206.2	206.2
Lowland Shrubland	385.4	112.0	(273.4)
Lowland Emergent	115.4	365.0	249.6
Upland Grass	0.0	0.0	0.0
Age Classes			
Young	271.1	533.8	262.7
Immature	1,325.9	3,259.8	1,933.9
Mature	2,587.0	460.2	(2,126.8)

Source: USFS 2010b.

[1] According to Tract 1 lands MIH table (Table 4.3.4-3).
[2] Total acres may be more or less than presented due to rounding.

Landscape Ecosystems

Land Exchange Alternative B would result in a decrease to the federal estate of 1,411.6 acres of the Jack Pine-Black Spruce landscape ecosystem, but result in an increase of 486.2 acres of the Lowland Conifer landscape ecosystem. Furthermore, there would be an increase in representation in the Dry-Mesic Red and White Pine landscape ecosystem (589.2 acres), Mesic Red and White Pine landscape ecosystem (528.0 acres), and the Mesic Birch-Aspen-Spruce-Fir landscape ecosystem (0.9 acres), and an overall increase of 192.7 acres (Table 4.3.4-9).

Similar to the Land Exchange Proposed Action, Land Exchange Alternative B would result in an increase to the federal estate in acreage of MIH types and age classes within various landscape ecosystems, and a decrease in acreage in others (Table 5.3.4-10). The greatest percentage increase in MIH acreage within a landscape ecosystem is upland forest (MIH 1) in the Lowland Conifer and Dry-Mesic Red and White Pine landscape ecosystems, while the greatest decrease is upland conifer forest (MIH 5) in the Jack Pine-Black Spruce landscape ecosystem. The largest percentage increase in age class acreage within a landscape ecosystem is the immature age class in the Lowland Conifer landscape ecosystem, while the largest decrease is in the immature age class in the Jack Pine-Black Spruce landscape ecosystem and the mature age classes within the

Jack Pine-Black Spruce and Lowland Conifer landscape ecosystems. Overall, the Dry-Mesic Red and White Pine landscape ecosystem would have the highest acreage increase of MIH types and age classes and the Jack Pine-Black Spruce landscape ecosystem would have the highest acreage decrease of MIH types and age classes.

Table 5.3.4-10 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes within Landscape Ecosystems in the Superior National Forest under Land Exchange Alternative B

Landscape Ecosystem Name			Dry-Mesic Red and White Pine	Jack Pine-Black Spruce	Lowland Conifer	Lowland Hardwood	Mesic Birch-Aspen-Spruce-Fir	Mesic Red and White Pine	Sugar Maple
Category			**Net Increase/(Decrease)**						
MIH Types	MIH 1	Acres [1]	437.8	(1,007.1)	340.3	0	0.9	501.1	0
		% [2]	2	(3)	2	0	0	1	0
	MIH 5	Acres	6.0	(998.2)	(100.1)	0	0	7.7	0
		%	0	(7)	(2)	0	0	0	0
	MIH 9	Acres	26.2	(290.9)	(10.5)	0	0	13.9	0
		%	1	(6)	0	0	0	0	0
	MIH 14	Acres	114.2	2.2	89.6	0	0	0.2	0
		% [3]	NA	NA	NA	NA	NA	NA	NA
Lowland Shrub		Acres	0	(66.4)	(207.3)	0	0	0.1	0
		%	0	(3)	(1)	0	0	0	0
Lowland Emergent		Acres	5.0	(23.5)	265.7	0	0	2.4	0
		%	1	(3)	4	0	0	0	0
Upland Grass		Acres	0	0	0	0	0	0	0
		%	0	0	0	0	0	0	0
Age Classes	Young	Acres	229.4	(21.5)	45.5	0	0	9.3	0
		%	14	(1)	4	0	0	0	0
	Immature	Acres	148.5	(528.7)	2,014.3	0	0.9	298.9	0
		%	1	(3)	26	0	0	1	0
	Mature	Acres	92.1	(726.1)	(1,709.8)	0	0	217.1	0
		%	1	(3)	(3)	0	0	1	0

Source: USFS 2010b; USFS 2011g.

[1] Total acres may be more or less than presented due to rounding.
[2] Percentage of acres increased or decreased within the entire landscape ecosystem in the Superior National Forest.
[3] MIH 14 is not tracked on the federal lands; thus, percentage is NA.

5.3.4.4.2 Invasive Non-native Plants

Land Exchange Alternative B would result in a reduction of occurrences of invasive non-native species on the smaller federal parcel, but in an increase of similar occurrences of invasive non-native species on Tract 1, including common tansy, orange hawkweed, and ox-eye daisy.

5.3.4.4.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Under Land Exchange Alternative B, a smaller portion of the federal lands would be exchanged for Tract 1. The same 11 ETSC plant species would be exchanged as for the Land Exchange Proposed Action, but fewer colonies would be exchanged. There are no known state-listed ETSC plant species located on Tract 1. Overall, 13 populations of 11 different species on the smaller federal parcel would be exchanged for none on Tract 1 (Table 5.3.4-11).

Table 5.3.4-11 Increase or Decrease to the Federal Estate of State-listed ETSC Plant Populations under Land Exchange Alternative B

	Land Exchange Alternative B: Smaller Federal Parcel Populations		Tract 1 Populations		
Plant Species (State Status/ Global Status[1])	**Total Populations[2,3]**	**Total Individuals[3]**	**Total Populations[2,3]**	**Total Individuals[3]**	**Net Species Increase/ (Decrease)**
Botrychium pallidum (E/G3)	1	2	0	NA	(1)
Botrychium rugulosum (T/G3)	1	4	0	NA	(1)
Botrychium simplex (SC/G5)	3	905	0	NA	(1)
Caltha natans (E/G5)	1	29	0	NA	(1)
Eleocharis nitida (T/G4)	1	~486 ft^2	0	NA	(1)
Juncus stygius var. *americanus* (SC/G5)	1	1	0	NA	(1)
Platanthera clavellata (SC/G5)	1	3	0	NA	(1)
Pyrola minor (SC/G5)	1	10	0	NA	(1)
Ranunculus lapponicus (SC/G5)	1	~919 ft^2	0	NA	(1)
Sparganium glomeratum (SC/G4)	1	28	0	NA	(1)
Torreyochloa pallida (SC/G5)	1	~25 ft^2	0	NA	(1)
Total	13	NA	0	NA	(11)

Source: MDNR 2013a.

[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 2011).

[2] Populations are interpreted from MDNR NHIS data using Element Occurrence; this differs from the DEIS, which used colonies as the population estimate.

[3] Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present. NA = Not Applicable.

Regional Foresters Sensitive Species

The USFS RFSS data layer indicates there are no RFSS plants on the federal lands, which includes the smaller federal parcel. However, several state-listed ETSC plant species occur on the smaller federal parcel and are also RFSS plants, including *Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, *Juncus stygius* var. *americanus*, and *Pyrola minor*.

There would be an increase to the federal estate in acres of upland forest (MIH 1) and aquatic habitat (MIH 14) as a result of Land Exchange Alternative B (Table 5.3.4-9), which means there would be the greatest opportunity to gain the RFSS plants listed under those categories in Table

4.2.4-5. There would be a decrease in acreage of upland conifer forest (MIH 5) and lowland black spruce-tamarack forest (MIH 9), which means the RFSS plant species that prefer these habitat types may also be decreased on National Forest System lands.

5.3.4.4.4 Biodiversity

The smaller federal parcel contains a high level of biodiversity because the majority of the parcel has been classified for inclusion in two MBS Sites of High Biodiversity Significance. Additionally, several different native plant communities exist on it, as well as 11 state-listed ETSC plant species. Because Tract 1 has not been fully studied, it is assumed to contain less biodiversity because it lacks MBS Sites of High Biodiversity Significance and native plant communities. However, inclusion of the preliminary Site of Outstanding Biodiversity Significance on Tract 1 would balance the exchange, if not make it more biodiverse than the smaller federal parcel. Table 5.3.4-1 provides a summary of the various data used to estimate biodiversity.

Land Exchange Alternative B would result in a decrease to the federal estate of 4,573.1 acres of MBS Sites of High Biodiversity Significance and a decrease of 0.3 acres of MBS Sites of Moderate Biodiversity Significance within the Laurentian Uplands subsection (Table 5.3.4-1). Portions of the west end of One Hundred Mile Swamp would remain in federal ownership.

Furthermore, Land Exchange Alternative B would result in removal from the Superior National Forest of three native plant communities that are ranked as “imperiled” to “vulnerable” in the state. As previously discussed, Tract 1 does not contain any MBS Sites of Biodiversity Significance or native plant communities, so, unlike the Land Exchange Proposed Action, the federal estate would not see an increase of either MBS Sites or native plant communities under this alternative.

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5.3.5 *Wildlife*

This section describes the environmental consequences of the Land Exchange Proposed Action to wildlife on the federal and non-federal lands. Effects from the change in federal ownership could be either beneficial or adverse, based on the change in species occurrences, habitat, and habitat connectivity on land that is under direct federal control.

The Land Exchange Proposed Action would have mixed effects for the Canada lynx. It would result in an increase in suitable habitat for lynx and for snowshoe hare (prey species) on the federal estate (although the amount of unsuitable lynx habitat would also increase). It would also result in a decrease of denning habitat and a decrease to the federal estate within designated LAUs. Critical lynx habitat would not change regardless of ownership.

Overall, the Land Exchange Proposed Action would result in an increase in the number of occurrences and habitat availability for four state-listed species, which include the gray wolf, the bald eagle, the Laurentian tiger beetle, and the trumpeter swan. The Land Exchange Proposed Action is not expected to result in changes to the three additional state-listed species, which include the wood turtle, the eastern heather vole, and the yellow rail.

Under the Land Exchange Proposed Action, one additional state-listed species and 22 additional SGCN would be affected due to their presence on the federally held lands. The Land Exchange Proposed Action would result in an increase of up to 579.6 acres of habitat in the Superior National Forest. While forested habitat would be decreased, shrubland/grassland and aquatic habitats would be increased as part of the Land Exchange Proposed Action. Under the Land Exchange Proposed Action, lands to be acquired would be managed by the USFS in accordance with the current Forest Plan. No activities are planned on these lands.

Under the Land Exchange Alternative B, one additional state-listed species but one less SGCN would be affected because they occur within the federal estate. Forest habitat under federal ownership would also decrease, though by a smaller amount than under the Land Exchange Proposed Action. Similarly, the Land Exchange Alternative B would result in an increase of 173.6 acres of habitat, with a distribution of habitat similar to the Land Exchange Proposed Action. As with the Land Exchange Proposed Action, lands acquired under the Land Exchange Alternative B would be managed by the USFS in accordance with the current Forest Plan. There are no activities planned on these lands.

Under the Land Exchange No Action Alternative, no action would be taken. No lands would be exchanged and no changes to wildlife species would be anticipated.

Table 5.3.5-1 Increase or Decrease of Special Status Wildlife Species on the Federal Estate Resulting from the Land Exchange

	Increase or (Decrease) of Special Status Wildlife Species			
Alternative	**Federally Listed Species**	**State-listed Species**	**Regional Forester Sensitive Species**	**Species of Greatest Conservation Need**
Land Exchange Proposed Action	0	1	0	22
Land Exchange Alternative B: Smaller Federal Parcel	0	1	0	(1)
Land Exchange No Action Alternative	0	0	0	0

Table 5.3.5-2 Increase or Decrease of Key Habitat Types on the Federal Estate Resulting from the Land Exchange

	Increase or (Decrease) of Acres[1] of Key Habitat Types				
Alternative	**Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)**	**Open Ground, Bare Soils (no MIH)**	**Grassland and Brushland, Early Successional Forest (no MIH)**	**Aquatic Environments (MIH 14)**	**Total Net Increase or (Decrease)**
Land Exchange Proposed Action	(787.9)	(63.8)	1,224.9	206.5	579.6
Land Exchange Alternative B: Smaller Federal Parcel	(1,279.3)	(29.1)	1,257.2	224.8	173.6
Land Exchange No Action Alternative	0	0	0	0	0

Source: Tables 5.3.4-2 and 5.3.4-7

[1] Total acres may be more or less than presented due to rounding.

5.3.5.1 Methodology and Evaluation Criteria

Evaluation was conducted to determine the potential effect that the Land Exchange Proposed Action would have on wildlife species from the following:

- a change in federal and state-listed ESTC, SGCN, RFSS, and other wildlife species; and
- a change in habitat availability, prey species habitat availability, habitat connectivity, and adjacent land use.

Analysis of wildlife species affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies, which included a comparison of the vegetation land cover and habitat types, forest age classes (young, immature, and mature), large mature forest patches, road and trail densities, federal and state-listed ESTC, SGCN, RFSS, and other wildlife species. GIS data and field observations for these categories were gathered to the extent possible and then compared over an area of analysis that included the federal and non-federal lands and LAU.

5.3.5.2 Land Exchange Proposed Action

5.3.5.2.1 Federally Listed Species

Canada Lynx

The federal lands of the Land Exchange Proposed Action include lynx habitat and habitat for lynx prey species. Lynx habitat includes a wide variety of upland and lowland habitats and forest types/ages, shrubland, and grasslands, but excludes aquatic environments and disturbed areas. Preferred denning habitat is typically found in mature forest and is generally more dependent on forest age classes, with trees older than saplings and with a dbh greater than 5 inches (immature and mature age classes; see Table 4.3.4-3). Snowshoe hare are the primary prey species for the Canada lynx, and hare habitat includes all types and age classes of forest and shrubland, but not aquatic environments, disturbed areas, or grassland/croplands (Table 5.3.5-3).

Table 5.3.5-3 Increase or Decrease in Suitable Habitat Types for Canada Lynx and Prey Species on the Federal Estate Resulting from the Land Exchange

Parcel	General Suitable Lynx Habitat (Acres[1])	Suitable Denning Habitat (Acres[1])	Suitable Snowshoe Hare Forage Habitat (Acres[1])	Unsuitable Lynx Habitat (Acres[1])
Land Exchange Proposed Action				
Federal Lands	6,371.5	5,413.1	6,365.3	123.9
Non-Federal Lands Total	6,808.4	5,364.3	6,776.7	250.8
Tract 1 – Hay Lake	4,675.1	3,720.0	4,643.4	251.1
Tract 2 – Lake County North	263.3	219.5	263.3	1.8
Tract 2 – Lake County South	112.8	48.4	112.8	4.0
Tract 3 – Wolf Lands 1	125.9	113.9	125.9	0.0
Tract 3 – Wolf Lands 2	767.9	683.8	767.9	0.0
Tract 3 – Wolf Lands 3	277.4	96.7	277.4	0.0
Tract 3 – Wolf Lands 4	404.7	359.7	404.7	0.0
Tract 4 – Hunting Club	150.7	92.2	150.7	9.6
Tract 5 – McFarland Lake	30.6	30.1	30.6	0.2
Total Increase or (Decrease)	436.9	(48.8)	411.4	126.9
Land Exchange Alternative B				
Smaller Federal Parcel	4,697.2	3,912.9	4,695.0	55.4
Tract 1 – Hay Lake	4,675.1	3,720.0	4,643.4	251.1
Total Increase or (Decrease)	(22.1)	(192.9)	(51.6)	195.7

Source: Tables 5.2.5-5, 4.3.4-3, and 4.3.4-8.

[1] Total acres may be more or less than presented due to rounding

As shown in Table 5.3.5-3, the federal lands of the Land Exchange Proposed Action include 6,371.5 acres of suitable general habitat for lynx. The non-federal lands include a total of 6,808.4 acres of potentially suitable habitat, which is an increase of 436.9 acres. Aquatic environments and disturbed areas are considered unsuitable habitat, along with lowlands with dead trees (though this habitat was not specifically called out in habitat/cover data). The Land Exchange Proposed Action would also result in an increase of 411.4 acres of hare habitat. However, the Land Exchange Proposed Action would result in a decrease of 48.8 acres of denning habitat and an increase of 126.9 acres of unsuitable lynx habitat.

Lynx utilize snow packed trails and roads as travel corridors. The federal lands do not contain any established snow packed trails (such as snowmobile trails) but are crossed by 6.9 miles of road surface. The non-federal lands are crossed by 0.03 mile of snow packed trail (snowmobile trail) and 2.2 miles of roads. The Land Exchange Proposed Action would result in a decrease of 4.7 miles of road and an increase of 0.03 mile of snow packed trails available for lynx use (Table 5.3.5-4).

Table 5.3.5-4 Increase or Decrease of Lynx Travel Corridors on the Federal Estate Resulting from the Land Exchange

Travel Corridor Type	Established Snow Pack Trails (Miles)	Established Roads (Miles)
Land Exchange Proposed Action		
Federal Lands	0.0	6.9
Non-Federal Lands Total	0.03	2.2
Tract 1 – Hay Lake	0.0	2.2
Tract 2 – Lake County North	0.0	0.0
Tract 2 – Lake County South	0.0	0.0
Tract 3 – Wolf Lands 1	0.0	0.0
Tract 3 – Wolf Lands 2	0.0	0.0
Tract 3 – Wolf Lands 3	0.03	0.0
Tract 3 – Wolf Lands 4	0.0	0.0
Tract 4 – Hunting Club	0.0	0.0
Tract 5 – McFarland Lake	0.0	0.0
Total Increase or (Decrease)	0.03	(4.7)
Land Exchange Alternative B		
Smaller Federal Parcel	0.0	6.9
Tract 1 – Hay Lake	0.0	2.2
Total Increase or (Decrease)	0.0	(4.7)

Source: USFS 2011e.

Land ownership immediately adjacent to the federal lands is a mix of private, state, and federal. The proximity of private lands and disturbance to the north and west may limit lynx passage and utilization of habitat on the federal lands.

Overall, the land ownership patterns surrounding the non-federal lands are mixed. Federal land proximity and, thus potential habitat connectivity, is marginal on Tract 1. Connectivity on the other tracts is generally more favorable. Located in less developed areas of the Superior National Forest, these tracts are generally bordered by federal, state, or county lands and are intended to reduce fragmentation. As such, the Land Exchange Proposed Action is likely to result in generally improved habitat connectivity overall.

Because all federal and non-federal lands are located within lynx critical habitat and would remain so regardless of ownership, the Land Exchange Proposed Action would not result in a change to lynx critical habitat. As previously discussed, LAU were identified for purposes of analysis and development of conservation measures for lynx (USFS 2004b). The federal lands are located within LAU 12 and the non-federal lands are located in LAU 4, 16, 21, 22, and 42. Tract 1 is not located within an LAU. The USFS indicated that no development or activities are planned on the non-federal lands, which means that there would be no increase in unsuitable habitat due to the Land Exchange Proposed Action (Table 5.3.5-5). As such, the percentage of currently unsuitable habitat in the overall LAU is not expected to change, nor would it affect the Forest Plan condition that unsuitable habitat not exceed 30 percent of the LAU (USFS Unpublished Data 2009).

Table 5.3.5-5 Increase or Decrease in Lynx Analysis Units on the Federal Estate Resulting from the Land Exchange

Parcel	Lynx Analysis Unit	Total Acres[1] of Proposed Land Exchange Federal/Non-Federal Land Within LAU	Overall Lynx Analysis Unit Acreage[1]	Current Percentage (%) Unsuitable[2] (Determined by USFS)
Land Exchange Proposed Action				
Federal Parcel	12	6,495.4	70,980.5	1.6
Non-Federal Lands Subtotal		2,149.7		
Tract 1 – Hay Lake	No LAU	NA	NA	NA
Tract 2 – Lake County North	16	265.2	76,108.3	2.1
Tract 2 – Lake County South	22	116.9	58,154.2	1.8
Tract 3 – Wolf Lands 1	16	126.0	76,108.3	2.1
Tract 3 – Wolf Lands 2	21	768.0	73,265.8	4.3
Tract 3 – Wolf Lands 3	21	277.5	73,265.8	4.3
Tract 3 – Wolf Lands 4	21	404.8	73,265.8	4.3
Tract 4 – Hunting Club	4	160.4	55,071.4	3.7
Tract 5 – McFarland Lake	42	30.9	32,305.4	1.2
Total Increase or (Decrease)		(4,345.7)		
Land Exchange Alternative B				
Smaller Federal Parcel	12	4,752.7		
Tract 1 – Hay Lake	No LAU	NA	NA	NA
Total Increase or (Decrease)		(4,752.7)		

Source: 2009 USFS SNF Monitoring and Evaluation Report.

Total acres may be more or less than presented due to rounding.

The Land Exchange Proposed Action would have mixed effects for the Canada lynx. It would result in an increase of overall suitable habitat for lynx and for snowshoe hare (prey species) to the federal estate (although the amount of unsuitable lynx habitat would also increase). It would also result in a decrease of denning habitat and a decrease of federal lands within designated LAU. Critical lynx habitat would not change regardless of ownership. As such, the Land Exchange Proposed Action is not likely to have either a net positive or negative effect on Canada lynx.

5.3.5.2.2 State-listed Species

Gray Wolf

The federal lands are likely part of a territory occupied by a single pack of wolves. The federal lands are dominated by trees that range in age from immature to mature, which is adequate cover habitat for wolves. Approximately 271 acres of young forest are present for forage opportunities (see Section 4.2.4.1) on the federal lands and 778 acres are present on the non-federal lands (Table 4.3.4-3). There are 5,413.1 acres of cover habitat on the federal lands and 5,364.3 acres on the non-federal lands. Gray wolves or their sign were observed on Tracts 1, 2, 3, and 5.

Table 5.3.5-6 Increase or Decrease in Gray Wolf Habitat on the Federal Estate Resulting from the Land Exchange

Parcel	Forage Habitat (Acres[1])	Cover Habitat (Acres[1])
Land Exchange Proposed Action		
Federal Lands	271.1	5,413.1
Non-Federal Lands Total	778.2	5,364.3
Tract 1 – Hay Lake	533.8	3,720.0
Tract 2 – Lake County North	24.4	219.5
Tract 2 – Lake County South	43.3	48.4
Tract 3 – Wolf Lands 1	2.2	113.9
Tract 3 – Wolf Lands 2	7.6	683.8
Tract 3 – Wolf Lands 3	130.4	359.7
Tract 3 – Wolf Lands 4	9.5	359.7
Tract 4 – Hunting Club	27.0	92.2
Tract 5 – McFarland Lake	0.0	30.1
Total Increase or (Decrease)	507.1	(48.8)
Land Exchange Alternative B		
Smaller Federal Parcel	271.1	3,912.9
Tract 1 – Hay Lake	533.8	3,720.0
Total Increase or (Decrease)	262.7	(192.9)

The amount of cover habitat is similar between the federal and non-federal lands, but the non-federal lands include more potential forage habitat; therefore, the Land Exchange Proposed Action would result in a very small decrease (48.8 acres) of cover habitat but would result in an increase of forage habitat (507.1) for the gray wolf.

Bald Eagle

As discussed in Section 5.2.5.2.1, eagles may utilize the area around the federal lands. The federal lands are located between the Embarrass and Partridge rivers, which eagles may use for foraging. Mud Lake may also be used for foraging. The nearest known nesting sites are more than 2 miles (5.8 miles south-southwest of the federal lands) from the federal lands and optimal habitat for nesting is not present. Eagles may utilize Mud Lake for nesting, though they tend to utilize larger lakes for nesting. Though optimal nesting and foraging habitat are not present in the federal lands, eagles may still utilize these areas.

Eagle habitat is present on several of the non-federal lands. Though they are smaller waterbodies than are optimal for eagles, Tract 1 includes the Pike River, Hay Lake, and Rice Lake. Tracts 2 and 3 are located near large lakes such as Pine and Greenwood. Tract 5 borders McFarland Lake, which is connected to other lakes within the BWCAW. With the exception of Tract 1, these lands are also further from developed mining areas and disturbances are less likely than on the federal lands. As such, the Land Exchange Proposed Action is likely to be of benefit to the bald eagle.

Wood Turtle

The only known population of wood turtles on the federal lands is downstream from the Mine Site, along the southern border of the federal lands. Though there is no known suitable habitat for wood turtles on the federal lands and no individuals are known to occur, wood turtles may use adjacent areas to the south of the federal lands. Similarly, no wood turtles or optimal wood turtle habitat was identified on the non-federal lands.

Given that no wood turtles or wood turtle habitat were identified on either the federal or non-federal lands, the Land Exchange Proposed Action would not result in an increase or decrease of individuals, populations, or suitable habitat.

Eastern Heather Vole

The eastern heather vole has not been observed during field surveys within 10 miles of the federal lands. Approximately 1,764.5 acres of potentially suitable habitat (upland deciduous forest, upland mixed forest, shrubland, and cropland/grassland) exists on the federal lands (Table 4.3.4-1), so the eastern heather vole could be present, but, if so, likely in very small numbers. The eastern heather vole was not identified on the non-federal lands by surveys or in the NHIS, but the non-federal lands contain 2,597.4 acres of habitat. As such, the Land Exchange Proposed Action would result in an increase of up to 832.9 acres of habitat.

Yellow Rail

The yellow rail was not found during surveys and was not reported in the NHIS database within 10 miles of the federal lands. As previously mentioned, small, scattered areas of its preferred habitat are present on the federal lands, but not the minimum nesting patch size needed for the species (approximately 36 acres, Table 4.3.3-1). No yellow rails or yellow rail habitat were identified on the non-federal lands. The Land Exchange Proposed Action would not result in a net change to the species or habitat.

Laurentian Tiger Beetle

The lack of suitable habitat and any recorded observations for the Laurentian tiger beetle suggest that the species does not occur on the federal lands. However, the habitat for the Laurentian tiger beetle is present at Tract 1, in an area formerly used as a sand and gravel mine. No disturbance activities are currently planned on the non-federal lands, so this potential habitat would be preserved. As such, the Land Exchange Proposed Action would result in an increase of suitable habitat for this species.

Trumpeter Swan

Trumpeter swans were observed on Tract 1 during surveys in 2009. A pair of adults with young was seen on Little Rice Lake. The species has not been observed on the federal lands. Because the species has been observed on the non-federal lands and not on the federal lands, the Land Exchange Proposed Action would result in an increase of the occurrence of this listed species within the federal estate.

5.3.5.2.3 Species of Greatest Conservation Need

Sections 4.3.5.1.1 and 4.3.5.2 discuss the SGCN in the context of their habitat. The federal lands include a wide variety of habitat types, grouped into key habitat types and MIH types (Table 5.3.5-7).

Some acreage of some key habitat types, MIH types, and cover types within the federal estate would increase through the Land Exchange Proposed Action, while others would decrease. The key habitat types that would increase or decrease under the Land Exchange Proposed Action are listed in Table 5.3.5-7. Species dependent on these habitat types are listed by ecological subsection in Tables 4.3.5-1 through 4.3.5-5.

Table 5.3.5-7 Increase or Decrease of Habitat Types for the Land Exchange Proposed Action on the Federal Estate

		Non-Federal Lands[1]					
Key Habitat Type and Management Indicator Habitat	Federal Lands Acres	Tract 1 – Hay Lake Lands Acres	Tract 2 – Lake County Lands Acres	Tract 3 – Wolf Lands Acres	Tract 4 – Hunting Club Lands Acres	Tract 5 – McFarland Lake Lands Acres	Net Increase or (Decrease) Acres
1. Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	5,719.7	2,978.8	337.2	1,479.4	105.7	30.6	(788.0)
2. Open Ground, Bare Soils (no MIH)	63.8	0.0	0.0	0.0	0.0	0.0	(63.8)
3. Grassland and Brushland, Early Successional Forest (no MIH)	651.8	1,696.3	38.9	96.5	45.0	0.0	1,224.9
4. Aquatic Environments (MIH 14)	60.1	251.1	5.8	0.0	9.6	0.2	206.6
Total	6,495.4	4,926.2	381.9	1,575.9	160.3	30.8	579.7

[1] According to non-federal land cover type summary tables (Tables 4.3.4-1, 4.3.4-12-20).

The Land Exchange Proposed Action would result in a decrease of 788.0 acres of forest habitat and 63.8 acres of open ground/bare soil to the federal estate. In addition, the Land Exchange Proposed Action would result in an increase of 1,224.9 acres of grassland/brushland and 206.6 acres of aquatic environment to the federal estate. Overall, the Land Exchange Proposed Action would result in an increase of up to 579.7 acres of habitat to the federal estate, though there would be a decrease of forest and open ground habitat. As such, forest-dependent species are more likely to be affected through habitat decrease by the Land Exchange Proposed Action. Grassland and brushland species (mostly bird species and one species of insect) would have more habitat available under the Land Exchange Proposed Action, as would species dependent on aquatic environments (bird species, reptile/amphibian species, and insect species). Overall, the Land Exchange Proposed Action would result in an increase of SGCN habitat.

5.3.5.2.4 Regional Forester Sensitive Species

Of the 18 terrestrial RFSS on the 2011 list for the Superior National Forest, the gray wolf, bald eagle, wood turtle, and eastern heather vole are discussed above as federally or state-listed species. Seven additional RFSS (the boreal owl, olive-sided flycatcher, bay-breasted warbler, Connecticut warbler, taiga alpine, Freija's grizzled skipper, and Nabokov's blue) are included as SGCN and are also discussed above.

Habitat for the three RFSS bats, the northern myotis, eastern pipistrelle, and little brown bat, may be present on the federal lands, though no hibernacula have been observed. Similarly, both forage and hibernation habitat may be present on the non-federal lands, though no hibernation sites have been observed. Bats were observed, though not identified to species, on Tract 1 during field studies in 2009. Because habitat, but no hibernation locations, have been identified on the federal or non-federal lands, the Land Exchange Proposed Action would not result in a net change of bat habitat within the federal estate for the RFSS bats. However, because bat species have been identified on the non-federal parcel, the Land Exchange Proposed Action may result in an increase of known RFSS bat species to the federal estate.

The northern goshawk may be occasionally present since goshawk nests have been observed on the federal parcel. Northern goshawk individuals and nests have also been identified on Tract 1. More forested habitat for the species is present on the federal lands than the non-federal lands (see Table 5.3.5-6). As such, the Land Exchange Proposed Action would result in a decrease of forested habitat available for the northern goshawk.

Though not observed during call surveys, the great gray owl may be occasionally present on the federal lands. Because owl calling surveys (ENSR 2005) found no great gray owls, populations in the area are likely small and/or occasional. No observations of great gray owls have been made on the non-federal lands. However, because the species utilizes forested habitat and the Land Exchange Proposed Action would result in a decrease of 788.0 acres of forested habitat, the Land Exchange Proposed Action would result in a decrease of this species' habitat.

A three-toed woodpecker was identified on the federal lands during surveys in 2000 and was observed on the parcel again in 2007. Area populations are expected to be low, and these habitat specialists require standing dead or dying trees where they can forage for bark beetles. The species has not been observed on the non-federal lands. As such, the Land Exchange Proposed Action would result in a decrease of this species' occurrence. Since the Land Exchange Proposed Action would result in a decrease of approximately 788.0 acres of forest, the Land Exchange Proposed Action would also result in a habitat decrease for this species.

The Quebec emerald dragonfly can inhabit wet meadow/sedge meadow. Approximately 36 acres of this habitat type are present on the federal lands. There has only been one documented occurrence of this species in Minnesota (Lake County 2006), and that occurrence was not on either the federal or non-federal lands. The non-federal lands do not contain any sedge/wet meadow wetlands. The Land Exchange would result in a decrease of potential habitat used by this species.

Other factors, such as lower disturbance levels and increase of contiguous habitat, would potentially increase RFSS utilization of the non-federal lands. The federal lands contain two stands of contiguous forest habitat greater than 300 acres (340.6 acres and 1,352.3 acres) while the non-federal lands include one forest stand greater than 300 acres (598.2 acres – Tract 3, Wolf Lands 2). The Land Exchange Proposed Action would result in a net decrease of 1,094.7 acres of contiguous habitat stands greater than 300 acres.

5.3.5.2.5 Other Wildlife Species

Other regionally common wildlife species, such as ravens, grouse, beaver, wolves, white-tailed deer, moose, fox, marten, and snowshoe hare, have been observed on both the federal and non-federal lands. Effects on wildlife species important to the Bands are discussed in Section 5.2.9 on a connected ecosystems level. Similar to SGCN, habitat for some other species of wildlife would increase via the Land Exchange Proposed Action while habitat would decrease for others. As previously discussed, forested habitat would decrease via the Land Exchange Proposed Action, but grassland/shrubland habitat and aquatic habitat would increase. Grassland and brushland species would have more habitat available under the Land Exchange Proposed Action, as would species dependent on aquatic environments. The Land Exchange Proposed Action would result in 579.7 additional acres of wildlife habitat.

5.3.5.3 Land Exchange Alternative B

Under the Land Exchange Alternative B, a smaller federal parcel would be exchanged for only one non-federal parcel, Tract 1. The effects that would result from this alternative are similar to those of the Land Exchange Proposed Action.

5.3.5.3.1 Federally Listed Species

Canada Lynx

As shown in Table 5.3.5-3, the smaller federal parcel includes 4,697.2 acres of suitable general habitat for lynx. Tract 1 has a total of 4,675.1 acres of habitat potentially suitable for the Canada lynx, which would result in a decrease of 22.1 acres to the federal estate. The Land Exchange Proposed Action would also result in a decrease of 192.9 acres of denning habitat. Snowshoe hare habitat would increase by 51.6 acres, but there would also be an increase of 195.7 acres of unsuitable lynx habitat to the federal estate under the Land Exchange Alternative B.

The smaller federal parcel does not contain any established snow packed trails (such as snowmobile trails) but is crossed by 6.9 miles of road surface. Tract 1 is crossed by 2.2 miles of roads and no established snow trails. Since lynx use snow packed trails and roads as travel corridors, the Land Exchange Alternative B would result in a decrease of 4.7 miles of road use for lynx.

Land ownership under the Land Exchange Alternative B would be similar to the Land Exchange Proposed Action, but the smaller federal parcel would be bordered to the north by USFS-managed federal lands. Tract 1 is bordered by federal lands to the north, west, and partially east, but the area is generally surrounded by private lands and developed areas. Habitat connectivity to Tract 1 is marginal. The Land Exchange Alternative B is likely to result in limited habitat connectivity overall. Similar to the Land Exchange Proposed Action, the smaller federal parcel and non-federal lands are located within lynx critical habitat and would remain so regardless of ownership; the Land Exchange Alternative B would not result in a change to lynx critical habitat. As shown in Table 5.3.5-5, the Land Exchange Alternative B would result in the decrease of 4,753 acres of land within an LAU because the federal parcel is within an LAU, but the Tract 1 lands are not.

The Land Exchange Alternative B would have mixed habitat effects for the Canada lynx. It would result in a decrease of overall suitable habitat for lynx and denning habitat, but would result in an increase of suitable snowshoe hare habitat. It would also result in a decrease of federal lands within designated LAUs. Critical lynx habitat would not change regardless of ownership. As such, the Land Exchange Alternative B is not likely to have either a net increase or decrease on Canada lynx.

5.3.5.3.2 State-listed Species

Gray Wolf

Gray wolves have been observed on both the smaller federal parcel and on Tract 1. Approximately 271 acres of forage habitat is present on the smaller federal parcel (young age class on Table 5.3.4-4) and 533.8 acres are present on Tract 1. There are 3,912.9 acres of cover habitat on the smaller federal parcel (immature and mature age classes) and 3,720.0 acres on Tract 1. This would result in an increase of 262.8 acres of forage habitat but also in a decrease of 192.9 acres of cover habitat.

Bald Eagle

As under the Land Exchange Proposed Action, the smaller federal parcel and surrounding areas may be utilized by bald eagles. Similar to the Land Exchange Proposed Action, the smaller federal parcel is also located between the Embarrass and Partridge rivers, which eagles may use for foraging. However, the smaller federal parcel excludes a portion of Mud Lake. The nearest known nesting sites are greater than 2 miles (5.8 miles south-southwest of the smaller federal parcel) from the federal lands and optimal habitat for nesting is not present.

Tract 1 contains waterbodies (Pike River, Hay Lake, and Rice Lake) and large trees, which eagles may use for nesting, though no nests have been observed. The nearest known eagle nest is approximately 4 miles southwest of the parcel. Given the potential habitat present on Tract 1, and the closer proximity to a known nest, the Land Exchange Alternative B is likely to be of benefit to the bald eagle.

Wood Turtle

No wood turtles or optimal wood turtle habitat were identified on Tract 1 or the smaller federal parcel. As such, the Land Exchange Alternative B would not result in an increase or decrease of habitat for the species.

Eastern Heather Vole

The eastern heather vole has not been observed during field surveys within 10 miles of the federal lands. There are 1,261.6 acres of potentially suitable habitat on the smaller federal parcel (Table 4.3.4-6). Eastern heather voles were not identified on the non-federal lands by surveys or in the NHIS, but Tract 1 contains 2,133.6 acres of habitat, which would result in an increase of 872.0 acres of habitat for the eastern heather vole. As such, the Land Exchange Alternative B would result in an increase of habitat for this species.

Yellow Rail

No yellow rail or optimal yellow rail habitat were identified on Tract 1 or the smaller federal parcel. Similar to the Land Exchange Prosed Action, the Land Exchange Alternative B would not result in a net change to the species or its habitat.

Laurentian Tiger Beetle

Similar to the Land Exchange Proposed Action, the lack of suitable habitat and any recorded observations for the Laurentian tiger beetle suggest that the species does not occur on the smaller federal parcel. However, habitat for the Laurentian tiger beetle is present on Tract 1, in an area formerly used as a sand and gravel mine. No disturbance activities are currently planned on Tract 1, so this potential habitat would be preserved. As such, the Land Exchange Alternative B, similar to the Land Exchange Proposed Action, would result in an increase of suitable habitat for the species.

Trumpeter Swan

Trumpeter swans were observed on Tract 1 during surveys in 2009. A pair of adults with young was seen on Little Rice Lake. The species has not been observed on the smaller federal parcel. Similar to the Land Exchange Proposed Action, because the species has been observed on Tract 1 but not on the smaller federal parcel, the Land Exchange Alternative B would result in an increase of the occurrence of this listed species within the federal estate.

5.3.5.3.3 Species of Greatest Conservation Need

Like the Land Exchange Proposed Action, the SGCN for the Land Exchange Alternative B are discussed in the context of their habitat. The smaller federal parcel also includes a wide variety of habitat types, grouped into key habitat types and MIH types (Table 5.3.5-8).

Similar to the Land Exchange Proposed Action, the Land Exchange Alternative B would result in a decrease of forest habitat (1,279.3 acres) and open ground/bare soil (29.1 acres). The Land Exchange Proposed Action, however, would result in an increase of grassland/brushland (1,257.2 acres) and aquatic environments (224.8 acres). Overall, the Land Exchange Proposed Action would result in an increase of up to 173.6 acres of habitat to the federal estate, though there would be a decrease of forest and open ground habitat. As such, forest-dependent species are more likely to be affected through habitat decrease under the Land Exchange Alternative B. Grassland and brushland species (mostly bird species and one species of insect) would have more habitat available under the Land Exchange Alternative B, as would species dependent on aquatic environments (bird species, reptile/amphibian species, and insect species). Overall, the Land Exchange Alternative B would result in an increase of SGCN habitat.

Table 5.3.5-8 Increase or Decrease of Habitat Types on the Federal Estate for the Land Exchange Alternative B

Key Habitat Type and Management Indicator Habitat	Smaller Federal Parcel (Acres)	Non-Federal Land Tract 1 (Acres)	Net Increase or (Decrease) (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	4,258.1	2,978.8	(1,279.3)
2. Open Ground, Bare Soils (no MIH)	29.1	0.0	(29.1)
3. Grassland and Brushland, Early Successional Forest (no MIH)	439.1	1,696.3	1,257.2
4. Aquatic Environments (MIH 14)	26.3	251.1	224.8
Total[1]	4,752.6	4,926.2	173.6

[1] Total acres may be more or less than presented due to rounding.

5.3.5.3.4 Regional Forester Sensitive Species

Habitat for the three RFSS bats, the northern myotis, eastern pipistrelle, and little brown bat, may be present on the smaller federal parcel, though no hibernacula have been observed. Bats were observed, though not identified to species, on Tract 1 during field studies in 2009. Because habitat has, but no significant hibernation locations have, been identified on the smaller federal parcel or Tract 1, the Land Exchange Alternative B would not result in a net change of bat habitat within the federal estate for the RFSS bats. However, because bats have been identified on Tract 1, the Land Exchange Alternative B may result in an increase of known RFSS bat species to the federal estate.

The northern goshawk may be occasionally present on the federal lands since a goshawk nest has been observed. Northern goshawk individuals and nests have also been identified on Tract 1. More forested habitat for the species is present on the smaller federal parcel than on Tract 1 (see Table 5.3.5-8). As such, the Land Exchange Alternative B would result in a decrease of forested habitat available for the northern goshawk.

Though not observed during call surveys, the great gray owl may be occasionally present on the smaller federal parcel. No observations of great gray owls have been made on Tract 1. However, because the species utilizes forested habitat and the Land Exchange Alternative B would result in a decrease of 1,279.3 acres of forested habitat, the Land Exchange Alternative B would result in a decrease of this species' habitat.

Three-toed woodpeckers were observed on or near the smaller federal parcel in 2000 and again in 2007. Area populations are expected to be low, and the species has not been observed on Tract 1. As such, the Land Exchange Alternative B would result in the decrease of this species' occurrence. Since the Land Exchange Alternative B would result in a decrease of 1,279.3 acres of forest, this would result in a habitat decrease for this species.

The Quebec emerald dragonfly has not been identified on the smaller federal parcel, as there has only been one documented occurrence of this species in Minnesota in Lake County in 2006 (Minnesota Odonta Survey Project 2012). Tract 1 does not contain any sedge/wet meadow wetlands, and so the Land Exchange Alternative B would result in a decrease of potential habitat used by this species.

Other factors, such as lower disturbance levels and increase of contiguous habitat, would potentially increase RFSS utilization of Tract 1 lands. The smaller federal parcel contains two stands of contiguous forest habitat greater than 300 acres (340.6 and 926.1 acres) while there are no stands greater than 300 acres on Tract 1.

5.3.5.3.5 Other Wildlife Species

Similar to the Land Exchange Proposed Action, forested habitat within the federal estate would decrease under the Land Exchange Alternative B, but grassland/shrubland habitat and aquatic habitat would be increased. Grassland and brushland species would have more habitat available under the Land Exchange Alternative B, as would species dependent on aquatic environments. The Land Exchange Alternative B would result in 173.6 additional acres of wildlife habitat.

5.3.5.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the current federal lands would remain in federal ownership and would continue to be managed under the General Forest – Longer Rotation Management Area and the General Forest Management Area. Wildlife would be directly affected by logging, mineral exploration, vehicle traffic, natural disturbances, and thinning activities, which would occur as planned by the USFS, and would be indirectly affected by changes in habitat caused by forest management. However, these activities would affect wildlife to a lesser degree than under the Land Exchange Proposed Action. Section 5.2.4.3.1 provides further discussion of the effects on management of cover types and habitat on the federal lands. Under the Land Exchange No Action Alternative, the USFS has an ongoing responsibility for managing wildlife resources on Superior National Forest lands in accordance with the Forest Plan (USFS 2004b). The Land Exchange No Action Alternative would not change the Forest Service's responsibility for managing wildlife resources and would result in no change in anticipated effects on existing wildlife.

Under the Land Exchange No Action Alternative, the non-federal lands would not go into USFS ownership, and land use would be determined by the private land owners. Effects on wildlife species are difficult to predict given the uncertainty of future potential land use. Lands may be developed, resulting in potential effects on individuals and local populations, habitat decrease, and effects on wildlife travel corridors.

5.3.6 Aquatic Species

This section describes the environmental consequences of the Land Exchange alternatives on aquatic biota, using comparisons of the existing conditions presented in Sections 4.2.6 and 4.3.6 to conditions after the Land Exchange alternatives in terms of net increase or decrease in aquatic species resources for the federal and non-federal lands.

The Land Exchange Proposed Action would result in a net increase of surface waters (MIH 14), including 110 acres of lakes and 4.5 miles of rivers. Additionally, it would result in an increase of 0.4 miles of first-order streams and 8.2 miles of third-order streams, and a decrease of 4.1 miles of second-order streams. The Land Exchange Proposed Action would result in an increase in watershed riparian connectivity and aquatic connectivity for the federal estate. Based on available data, the Land Exchange Proposed Action would potentially result in an increase of nine additional fish species, while the macroinvertebrate assemblage would be similar. The Land Exchange Proposed Action could result in an increase of six new potential SGCN species, based on eco-region data.

Land Exchange Alternative B would result in a net increase of surface waters (MIH 14), including 132.6 acres of lakes and 3.1 miles of rivers. Additionally, it would result in a decrease of 1.0 miles of first-order streams and 4.1 miles of second-order streams, and an increase of 8.2 miles of third-order streams. Land Exchange Alternative B would result in an increase in watershed riparian connectivity and aquatic connectivity for the federal estate. Based on available data, Land Exchange Alternative B would potentially result in a decrease of four fish species, while the macroinvertebrate assemblage would likely be similar. Land Exchange Alternative B would result in no net change of SGCN species, based on eco-region data.

The Land Exchange No Action Alternative would not result in any increase or decrease of aquatic habitats or SGCN species to the federal estate.

5.3.6.1 Methodology and Evaluation Criteria

The criteria used to describe the direct and indirect effects of the Land Exchange alternatives focused on the ecological integrity of the aquatic systems present at the federal land and non-federal lands where physical, chemical, and biological characteristics that are important to biotic quality were considered. The spatial and temporal area of analysis for aquatic resources included the federal and non-federal lands that are proposed for the exchange based on current conditions.

The methodology used for analysis of the Land Exchange alternatives included review and evaluation of available literature, aerial photography review, and GIS analysis of all surface waters and aquatic species habitat present within the Land Exchange areas. Both quantitative and qualitative analyses were used. The analysis of the aquatic resources affected by the Land Exchange alternatives was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies as follows:

- change in the amount of Superior National Forest MIHs (MIH 14 [aquatic habitat]) available for species on the federal and non-federal lands;
- changes in the length of stream segments;
- changes in the area of lake or deepwater wetland;

- qualitative determination of community habitat and ecological value;
- qualitative assessment of the aquatic connectivity (network created by streams, rivers, and lakes as they flow into one another) and the potential for barriers to fish passage; and
- net change in aquatic species.

5.3.6.2 Land Exchange Proposed Action

5.3.6.2.1 Surface Water Features (MIH 14)

Comparing the footprints of the surface water features present within the federal and non-federal lands provides a direct assessment of the increase or decrease in aquatic environments that support aquatic biota and associated habitats. This comparison was made by analyzing the linear shoreline frontage and frontage index of the surface water features within the federal and non-federal lands, where the frontage index indicates the linear feet of lake and shoreline frontage per acre of land.

The Land Exchange Proposed Action would result in a net increase of surface water resources to the federal estate (Table 5.3.6-1). A net increase of approximately 111 acres of lake and 4.5 miles of rivers would be added to the federal estate from the Land Exchange Proposed Action. For both lakes and streams, the frontage index would increase substantially as a result of the exchange.

Table 5.3.6-1 Federal and Non-federal Land Surface Water Comparisons

	Lake			Rivers/Creeks/Streams		
Parcel	**Acres**	**Frontage (ft)**	**Frontage Index (shoreline/acre)**	**Miles**	**Frontage (linear ft)[1]**	**Frontage Index (shoreline/acre)[2]**
Lands Conveyed						
Federal Lands	30.5	4,550.0	0.7	5.1	53,856.0	8.3
Lands Acquired						
Tract 1	141.5	17,100.0	3.5	8.2	73,392.0	14.9
Tract 2	0.0	0.0	0.0	0.0	0.0	0.0
Tract 3						
Wolf Lands 1	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Lands 2	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Lands 3	0.0	0.0	0.0	0.3	2,745.6	9.9
Wolf Lands 4	0.0	0.0	0.0	1.1	11,932.8	29.5
Tract 4	0.0	0.0	0.0	0.0	0.0	0.0
Tract 5	0.0	900.0	32.1	0.0	0.0	0.0
Total Non-federal lands	141.5	18,000.0	35.6	9.6	88,070.4	54.3
Net Change						
Net Increase (Decrease)	111.0	13,450.0	34.9	4.5	34,214.4	46.0

Note: Surface water shoreline distance calculated by GIS analysis.

1 Includes shoreline distance on both sides of streams.
2 Frontage Index calculated by dividing total acres of parcel by total shoreline within parcel.

5.3.6.2.2 Differences of Strahler Stream Orders and Habitat

For the purposes of this SDEIS, the Strahler Order (USEPA 2011a) is used to describe the hierarchical ordering of streams, where a first-order stream describes a headwater type stream with no branching. Where two first-order streams meet, they become larger second-order streams and where two second-order streams meet, they become larger third-order streams, etc. A quantitative comparison of the Strahler Stream Order indicates the Land Exchange Proposed Action would result in an increase of 0.4 miles of first-order headwater streams and 8.2 miles of third-order streams, and a decrease of 4.1 miles of second-order streams to the federal estate (Table 5.3.6-2).

The net increase of third-order streams and decrease in second-order streams would likely add more habitat diversity to the Superior National Forest since, generally, stream habitat diversity increases with higher-order streams. No significant habitat increases or decreases would likely occur associated with the slight changes in first-order, headwater streams as a result of the Land Exchange Proposed Action.

Table 5.3.6-2 Increase or Decrease of Stream Orders from the Land Exchange Proposed Action

	Stream Distance (miles)		
Parcel (Stream)	**1st order**	**2nd order**	**3rd order**
Lands Conveyed			
Federal Lands (Yelp Creek)	1.0	4.1	0
Lands Acquired			
Tract 1 – Hay Lake (Pike River)	0	0	8.2
Tract 2 – Lake County	0	0	0
Tract 3			
Wolf Lands 1	0	0	0
Wolf Lands 2	0	0	0
Wolf Lands 3 (Coyote Creek)	0.3	0	0
Wolf Lands 4 (Coyote Creek)	1.1	0	0
Tract 4 – Hunting Club	0	0	0
Tract 5 – McFarland	0	0	0
Total Non-federal Lands	1.4	0	8.2
Net Increase (Decrease)	**0.4**	**(4.1)**	**8.2**

Note: Surface water shoreline distance calculated by GIS analysis.

5.3.6.2.3 Watershed Level Riparian and Aquatic Connectivity

Riparian Connectivity

Intact riparian areas are the foundation of diverse and productive aquatic ecosystems and function to maintain available water quality and physical habitat. The streams present on the federal and non-federal lands (Partridge River, Pike River, and Coyote Creek) are each part of an intricate web of perennial streams, creeks, and rivers that makes up a larger watershed. The connections between these surface water features are affected by the vegetated, undisturbed riparian edges bordering these water bodies. A comparison of the watersheds using the RCI is presented in Table 5.3.6-3. The index was developed from GIS analysis of vegetative cover along riparian areas where agriculture and land development have affected natural riparian vegetative cover.

The Land Exchange Proposed Action would result in a slight increase in watershed riparian connectivity, which indicates that the streams on both the federal and non-federal lands are located within watersheds with existing high-quality riparian connectivity.

Table 5.3.6-3 Watershed Riparian Connectivity Index Comparison

Surface Water	Tract	Watershed	Percent Agriculture in Riparian Zone	Percent Development in Riparian Zone	RCI Score[1]
Lands Conveyed					
Partridge River	Federal Lands	St. Louis	0	5	95
Lands Acquired					
Pike River	Hay Lake	Vermillion	0	1	99
Coyote Creek	Wolf Lands 3 and 4	Rainy River-Headwaters	0	0	100
Net Increase (Decrease)[2]			0	(4)	4.5

Adopted from MDNR 2012a.

[1] RCI score calculated with MDNR formula using Percent Agriculture and Percent Development in Riparian Zone; scale is from 0 to 100 where 100 indicates excellent riparian conductivity.
[2] Non-federal lands averaged to determine net increase/decrease.

Aquatic Connectivity

Structures within streams, such as dams, bridges, and culverts reduce the longitudinal and lateral connectivity of the watershed. These structures can degrade the aquatic habitat in the watershed by slowing stream flow, increasing sedimentation, incising stream channels, changing the depth, and disconnecting portions of streams from the floodplain. The ACI was developed from GIS analysis of number of structures per stream mile for each watershed, and the watershed ACI scores were used to provide a comparison of each watershed.

The Land Exchange Proposed Action would result in the Superior National Forest acquiring streams located in watersheds with better aquatic connectivity values (Table 5.3.6-4).

Table 5.3.6-4 Watershed Aquatic Connectivity Index Comparison

Surface Water	Tract	Watershed	Aquatic: Bridges and Culverts (miles stream/# structures)	Aquatic: Dams (miles stream/# structures)	ACI Score[1]
Lands Conveyed					
Partridge River	Federal Lands	St. Louis	15	6	11
Lands Acquired					
Pike River	Hay Lake	Vermillion	41	11	26
Coyote Creek	Wolf Lands 3 and 4	Rainy River-Headwaters	89	19	54
Net Increase (Decrease)[2]			50	9	29

Adopted from MDNR 2012b.

1 ACI score calculated by dividing total miles of streams and ditches per watershed by total number of culverts, bridges, and dams; scale is from 0 to 100 where 100 indicates free flowing streams (no structures) and 0 indicates one structure for every 20 miles of flowing water.
2 Non-federal lands averaged to determine net increase/decrease.

5.3.6.2.4 Aquatic Species

A complete quantitative comparison of the net increase or decrease of aquatic species cannot be made for the purposes of the Land Exchange Proposed Action due to the absence of complete baseline information. Only the federal lands had aquatic biota and habitat sampling sites within the parcel boundaries. However, a semi-quantitative comparison can be made for species located within the vicinity of the non-federal parcel boundaries since representative survey sites located in the vicinity of the parcels were likely similar to the existing aquatic habitats present at each parcel (see Section 4.2.6).

Fish Assemblages

Two survey sites were analyzed within the vicinity of the federal lands while four survey sites were analyzed among the non-federal lands (in the vicinity of Pike River and Coyote Creek; see Figure 5.3.6-1). The federal and non-federal lands had 11 species in common. The Land Exchange Proposed Action would potentially result in an increase of nine additional species, including one pollution intolerant species and one pollution tolerant species (Table 5.3.6-5 and 5.3.6-7). Given the fact that representative survey sites were used for non-federal lands, it is possible that some species are more or less prevalent than is noted here.

The fish assemblages located at each survey site indicate that the Land Exchange Proposed Action would result in minimal change to the fish assemblages for the streams the Superior National Forest would acquire. Additionally, the dominant fish species present at each site (Table 5.3.6-6) indicate that the stream characteristics were consistent with slower moving, glide pool features with the exception of the segment on the Stony River where the MCAB_05RN024 survey site was located. This site exhibited dominant longnose dace populations which indicated riffle-run habitats were likely present as described in Section 4.2.6.

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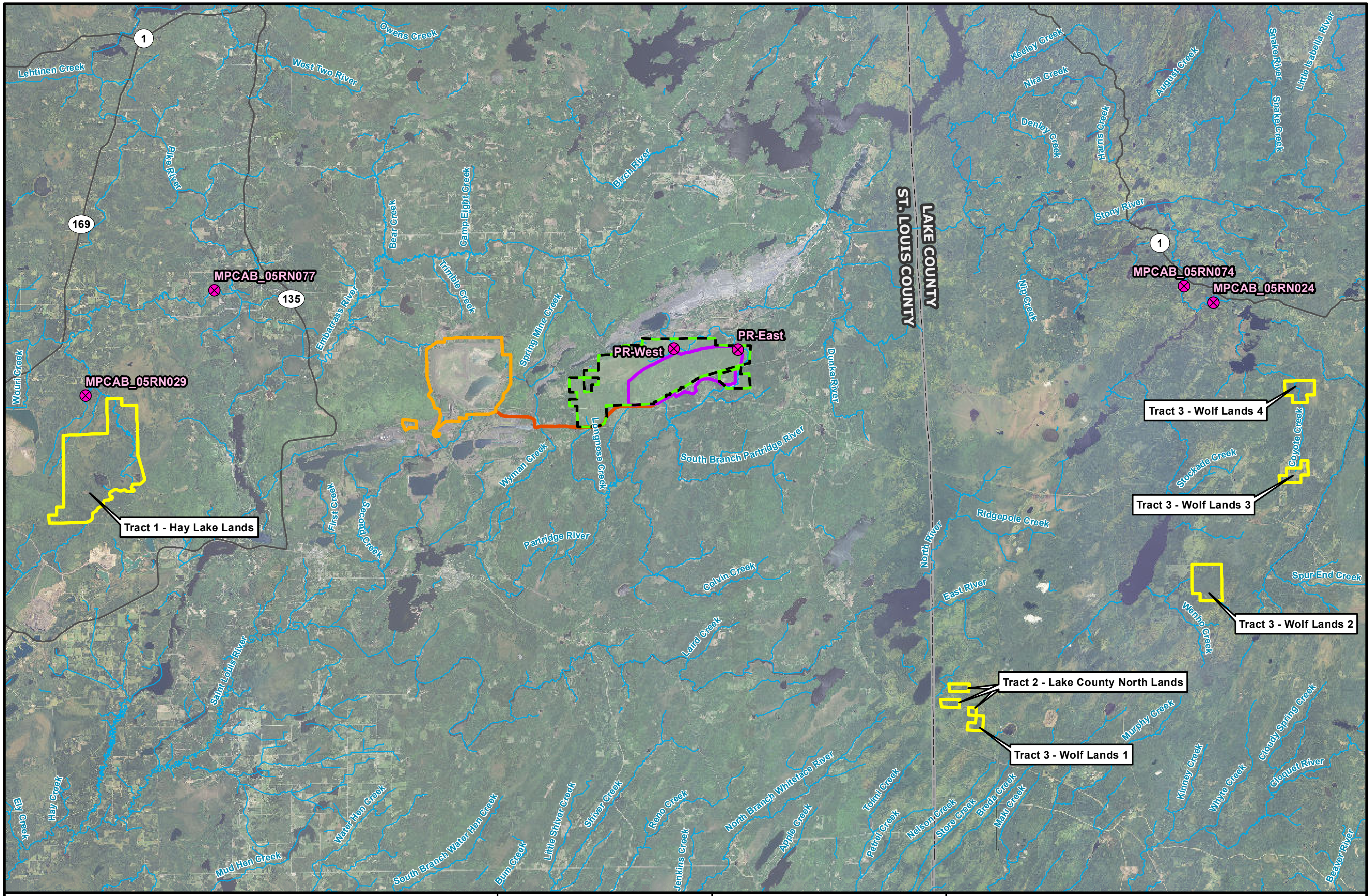

Study Site
Federal Lands
Non-federal Lands
Mine Site
Plant Site
Trasportation and Utility Corridor
Streams/Rivers
Existing Road

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

0 1.5 3 6 Miles

Figure 5.3.6-1
Federal and Non-federal Lands Aquatic Study Area
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

DRAFT SUBJECT TO REVISION

April 2013

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Table 5.3.6-5 Increase or Decrease of Stream Fish Assemblage for the Land Exchange Proposed Action

Species	Common Name	Tolerance Designation	Federal Land Parcel	Non-federal Land Parcels
Catostomus commersonii	White sucker	tolerant	X	X
Luxilus cornutus	common shiner	intolerant	X	X
Notemigonus crysoleucas	golden shiner	Tolerant		X
Notropis heterolepis	blacknose shiner	Intolerant		X
Notropis hudsonius	spottail shiner	Intermediate		X
Notropis volucellus	mimic shiner	Intolerant		X
Etheostoma nigrum	Johnny darter	intermediate	X	X
Perca flavescens	yellow perch	--		X
Sander vitreus	Walleye	--		X
Percina caprodes	logperch	Intermediate		X
Lota lota	burbot	--	X	X
Ambloplites rupestris	rock bass	--		X
Micropterus dolomieu	smallmouth bass	--		X
Esox lucius	northern pike	--	X	X
Phoxinus eos	northern redbelly dace	tolerant	X	
Culaea inconstans	brook stickleback	intolerant	X	X
Phoxinus neogaeus	finescale dace	--		X
Rhinichthys atratulus	blacknose dace	intolerant	X	
Rhinichthys cataractae	longnose dace	intolerant	X	X
Semotilus margarita	pearl dace	--	X	
Noturus gyrinus	tadpole madtom	intermediate	X	X
Umbra limi	central mudminnow	tolerant	X	X
Hybognathus hankinsoni	brassy minnow	--	X	
Pimephales promelas	fathead minnow	tolerant	X	X
Cottus bairdii	mottled sculpin	intermediate	X	X
Semotilus atromaculatus	creek chub	Tolerant		X
Coregonus clupeaformis	lake whitefish	--		X
Total Species			15	23
# Intolerant Species			4	5
# Tolerant Species			4	5
Net Increase or Decrease Species			(8)	8
Net Increase or Decrease Intolerant Species			(1)	1
Net Increase or Decrease Tolerant Species			(1)	1

-- = no designation assigned

Table 5.3.6-6 Dominant Fish Species Present at Study Sites

Attributes	Federal Parcel (within parcel)		Non-federal Land (study areas within vicinity of Tract 1)		Non-federal Land (study areas within vicinity of Tract 3- Wolf Lands 3 and 4)	
Study site	PR-west	PR-east	MPCAB-05RN029	MPCAB-05RN077	MPCAB-05RN024	MPCAB-05RN074
Dominant Species	Brook stickleback	Northern redbelly dace	White sucker	White sucker	Longnose dace	Blacknose shiner

Adopted from Barr 2011b and MPCA 2011c.

Table 5.3.6-7 Increase or Decrease of Stream Fish Assemblage for the Land Exchange Proposed Action

Combined Studies Within, or Within Vicinity of, Surface Water	Tract	Total Species (#)	Pollution Intolerant Species (#)	Pollution Tolerant Species (#)
Lands Conveyed				
Partridge River	Federal Lands	15	4	4
Lands Acquired				
Pike River	Tract 1	14	4	4
Coyote Creek	Tract 3 - Wolf Lands 3 and 4	18	4	4
Total Non-Federal Lands		24	5	5
Net Increase (Decrease)		9	1	1

Adopted from Section 4.2.6.

Benthic Macroinvertebrate Assemblages

Macroinvertebrate baseline surveys completed within and in the vicinity of the federal lands ranked macroinvertebrate assemblages as fair within the second-order stretches of the Partridge River, as indicated by the HBI (Table 5.3.6-8). The first-, third-, and fourth-order segments of the streams within the vicinity of the non-federal lands indicated macroinvertebrate assemblages ranging from good to fair. A qualitative comparison using the attributes of HBI, stream order, total families (diversity), and percent pollution tolerant organisms indicate that the macroinvertebrate assemblages likely would remain the same under the Land Exchange Proposed Action. This qualitative comparison assumes the habitat and associated macroinvertebrate assemblages are similar in the stream segments within the non-federal lands boundaries including the third-order segment of the Pike River on Tract 1 and the first-order segments of Coyote Creek within Tract 3 (Figure 5.3.6-1).

Table 5.3.6-8 Stream Macroinvertebrate Assemblage Comparisons for the Land Exchange Proposed Action

Attributes	Federal Parcel (within parcel)		Non-federal Land (study areas within vicinity of Tract 1)		Non-federal Land (study areas within vicinity of Tract 3- Wolf Lands 3 and 4)	
Study site	PR-west	PR-east	MPCAB-05RN029	MPCAB-05RN077	MPCAB-05RN024	MPCAB-05RN074
Stream order	2	2	1	4	3	4
HBI score	6.4	6.0	5.7	5.1	5.9	5.2
HBI ranking	Fair	Fair	Fair	Good	Fair	Good
Total families	11	10	11	31	23	27
Percent pollution tolerant	8	18	3	5	10	26

Adopted from Barr 2011b and MPCA 2011c.

5.3.6.2.5 Aquatic Species of Greatest Conservation Need

The MDNR and USFS have developed the ECS for ecological mapping and landscape classification (MDNR 2011a), which defines uniform ecological features within a mapped area. The federal and non-federal lands are located in the Northern Superior Uplands Section of the Laurentian Mixed Forest Province. These lands are further divided into several subsections. The federal lands include the Laurentian and Nashwauk Uplands subsections while the non-federal lands include these two subsections and the Border Lakes subsection.

As discussed in Section 4.2.6.1.4, SGCN aquatic species are associated with these ecological subsections based on occurrence and habitat considerations. Using the approach of comparing SGCN species by subsection association only, the Land Exchange Proposed Action could result in an increase of six new potential SGCN species (Table 5.3.6-9). Of these, the spoonhead sculpin, lake chub, and longear sunfish have the highest potential to be found near the shoreline habitat of Tract 5 (within the Border Lakes subsection).

Regardless of the potential indicated by subsection association, no SGCN species were identified within the boundaries of the federal or non-federal lands during field surveys. While habitat is present in at least some locations within these boundaries for SGCN species, the surveys performed within the vicinity of the federal lands found no SGCN aquatic species, suggesting that SGCN species are likely not present on the federal lands. Conversely, occurrences of the creek heelsplitter, an SGCN species, have been documented within the vicinity of the non-federal lands on segments of the Pike River (downstream of Tract 1) and the Stony River (downstream of Tract 3) as discussed in Section 4.3.6.2. The predominant sand substrate documented in survey areas within the vicinity of these SGCN occurrence locations and the possibility that similar substrates exist within the boundaries of Tract 1 and Tract 3 indicate the creek heelsplitter may exist within the river segments of these non-federal lands. A qualitative review of these data indicates the Land Exchange Proposed Action may result in the added presence of the creek heelsplitter.

Table 5.3.6-9 Eco-region SGCN Species Comparisons for the Land Exchange

SGCN Species	Common Name	Federal Land (Laurentian and Nawshauk Uplands)	Non-federal Lands (Laurentian Uplands, Nawshauk Uplands, Border Lakes)
Fish			
Acipenser fulvescens	lake sturgeon		X
Coregonus nipigon	nipigon cisco		X
Coregonus zenithicus	shortjaw cisco		X
Cottus ricei	spoonhead sculpin		X
Couesius plumbeus	lake chub		X
Ichthyomyzon fossor	brook lamprey	X	X
Lepomis megalotis	longear sunfish		X
Mussels			
Lasmigona compressa	creek heelsplitter	X	X
Ligumia recta	black sandshell	X	X
Total species		3	9

Adopted from Section 4.3.6.

5.3.6.3 Land Exchange Alternative B

5.3.6.3.1 Surface Water Features (MIH 14)

Land Exchange Alternative B would result in a net increase of lake and river surface water features to the federal estate (Table 5.3.6-10). A net increase of approximately 133 acres of lake and 3.1 miles of rivers would be added to the Superior National Forest under this alternative. The increase in lake and river frontage would provide a net increase of habitat for aquatic species (MIH 14). The frontage index would increase for both lakes and streams as a result of Land Exchange Alternative B.

Table 5.3.6-10 Frontage of Waterways for Land Exchange Alternative B

Parcel	Lake Acres	Lake Frontage (ft)	Lake Frontage Index (shoreline/acre)	Rivers/Creeks/Streams Miles	Rivers/Creeks/Streams Frontage (linear ft)[1]	Rivers/Creeks/Streams Frontage Index (shoreline/acre)[2]
Lands Conveyed						
Land Exchange Alternative B	8.9	1,200.0	0.3	5.1	53,856.0	11.3
Lands Acquired						
Tract 1	141.5	17,100.0	3.5	8.2	73,392.0	14.9
Net Change						
Net Increase (Decrease)	132.6	15,900.0	3.2	3.1	19,536.0	3.6

Note: Surface water shoreline distance calculated by GIS analysis.

[1] Includes shoreline distance on both sides of streams.
[2] Frontage Index calculated by dividing total acres of parcel by total shoreline within parcel.

5.3.6.3.2 Differences of Strahler Stream Orders and Habitat

A quantitative comparison of the Strahler Stream Order indicates that Land Exchange Alternative B would result in a decrease of 1.0 and 4.1 miles of first- and second-order streams, respectively, and an increase of 8.2 miles of third-order streams to the federal estate (Table 5.3.6-11).

As with the Land Exchange Proposed Action, the net increase of third-order streams and decrease in first- and second-order streams would likely add more habitat diversity to the Superior National Forest. The net decrease of first-order streams would slightly reduce the amount of available spawning habitat for some aquatic species as headwater streams provide specialized spawning habitat for some species.

Table 5.3.6-11 Increase or Decrease of Stream Orders from Land Exchange Alternative B

	Stream Distance (miles)		
Parcel (Stream)	**1st order**	**2nd order**	**3rd order**
Lands Conveyed			
Federal Lands (Yelp Creek)	1.0	4.1	0
Lands Acquired			
Tract 1 – Hay Lake (Pike River)	0	0	8.2
Net Increase (Decrease)	**(1.0)**	**(4.1)**	**8.2**

Note: Surface water shoreline distance calculated by GIS analysis.

5.3.6.3.3 Watershed Level Riparian and Aquatic Connectivity

Riparian Connectivity

A comparison of the watersheds containing streams present on the federal parcel (Partridge River) and Tract 1 (Pike River) using the RCI is presented in Table 5.3.6-12. The index was developed from GIS analysis of vegetative cover along riparian areas where agriculture and land development have affected natural riparian vegetative cover.

Under Land Exchange Alternative B, there would be a slight increase in watershed riparian connectivity. The streams on both the federal lands and Tract 1 are located within watersheds with existing high quality riparian connectivity.

Table 5.3.6-12 Watershed Riparian Connectivity Index Comparison

Surface Water	**Tract**	**Watershed**	**Percent Agriculture in Riparian Zone**	**Percent Development in Riparian Zone**	**RCI Score[1]**
Lands Conveyed					
Partridge River	Federal Lands	St. Louis	0	5	95
Lands Acquired					
Pike River	1 - Hay Lake	Vermillion	0	1	99
Net Increase (Decrease)			0	(4)	4.0

Adopted from MDNR 2012a.

[1] RCI score calculated with MDNR formula using *Percent Agriculture and Percent Development in Riparian Zone*; scale is from 0 to 100 where 100 indicates excellent riparian conductivity.

Aquatic Connectivity

Land Exchange Alternative B would result in the Superior National Forest acquiring streams located in watersheds with significantly better aquatic connectivity values, indicating increased aquatic habitat.

Table 5.3.6-13 Watershed Aquatic Connectivity Index Comparison

Surface Water	Tract	Watershed	Aquatic: Bridges and Culverts (miles stream/# structures)	Aquatic: Dams (miles stream/# structures)	ACI Score[1]
Lands Conveyed					
Partridge River	Federal Lands	St. Louis	15	6	11
Lands Acquired					
Pike River	1 - Hay Lake	Vermillion	41	11	26
Net Increase (Decrease)			26	5	15

Adopted from MDNR 2012b.

1 ACI score calculated by dividing total miles of streams and ditches per watershed by total number of culverts, bridges, and dams; scale is from 0 to 100 where 100 indicates free flowing streams (no structures) and 0 indicates one structure for every 20 miles of flowing water.

5.3.6.3.4 Aquatic Species

As with the Land Exchange Proposed Action, a semi-quantitative comparison of the net increase or decrease of aquatic species was made for species located within the vicinity of the Tract 1 parcel boundaries since representative survey sites located in the vicinity of the parcel were likely similar to the existing aquatic habitats present at the parcel (see Section 4.2.6).

Fish Assemblages

Two survey sites were analyzed within the vicinity of both the federal lands and within the vicinity of Tract 1. The federal lands and Tract 1 had six species in common. Land Exchange Alternative B would potentially result in a net decrease of four species, including two pollution-intolerant species (Table 5.3.6-14). Given the fact that only representative survey sites were used for Tract 1, it is possible that some species are more or less prevalent than is noted here. The attributes of the fish assemblages located at each survey site indicate that Land Exchange Alternative B would result in minimal change to the fish habitat for the portions of the river the Superior National Forest would acquire. The dominant fish species present at each site indicate that the stream characteristics were consistent with slower-moving, glide pool features.

Table 5.3.6-14 Increase or Decrease of Stream Fish Assemblage for Land Exchange Alternative B

Combined Studies Within, or Within Vicinity of, Surface Water	Tract	Total Species (#)	Pollution Intolerant Species (#)	Pollution Tolerant Species (#)
Lands Conveyed				
Partridge River	Federal Lands	15	4	4
Lands Acquired				
Pike River	Tract 1	11	2	4
Net Increase (Decrease)		(4)	(2)	0

Adopted from Section 4.2.6.

Benthic Macroinvertebrate Assemblages

Macroinvertebrate baseline surveys completed within, and in the vicinity of, the federal lands ranked macroinvertebrate assemblages as fair within the second-order stretches of the Partridge River, as indicated by the HBI pollution index (Table 5.3.6-15). The first- and fourth-order segments of the streams within the vicinity of Tract 1 indicated macroinvertebrate assemblages ranging from good to fair. A qualitative comparison using the attributes of HBI, stream order, total families (diversity), and percent pollution tolerant organisms indicate that the macroinvertebrate assemblages would likely be similar under Land Exchange Alternative B. This qualitative comparison assumes the habitat and associated macroinvertebrate assemblages are similar in the stream segments within the third-order segment of the Pike River on Tract 1.

Table 5.3.6-15 Stream Macroinvertebrate Assemblage Comparisons for Land Exchange Alternative B

Attributes	Federal Parcel (within parcel)		Non-federal Land (study areas within vicinity of Tract 1)	
Study site	PR-west	PR-east	MPCAB-05RN029	MPCAB-05RN077
Stream order	2	2	1	4
HBI score	6.4	6.0	5.7	5.1
HBI ranking	Fair	Fair	Fair	Good
Total families	11	10	11	31
Percent pollution tolerant	8	18	3	5

Adopted from Barr 2011b and MPCA 2011c.

5.3.6.3.5 Aquatic Species of Greatest Conservation Need

The federal lands include the Laurentian and Nashwauk Uplands ecological subsections, while Tract 1 includes only the Nashwauk Uplands.

As discussed in Section 5.3.6.2.5, SGCN species are associated with these ecological subsections based on occurrence and habitat considerations. Using the approach of comparing SGCN species by subsection association only, Land Exchange Alternative B would likely result in no net change of SGCN species (Table 5.3.6-16).

Regardless of the potential indicated by subsection association, no SGCN species were identified within the boundaries of the federal lands. Habitat is present in at least some locations within these boundaries for SGCN species. Although no surveys were completed within the boundaries of Tract 1, occurrences of the creek heelsplitter, an SGCN species, have been documented within the vicinity of Tract 1 on segments of the Pike River (downstream of Tract 1). The predominant sand substrate documented in survey areas within the vicinity of this SGCN occurrence location and the possibility that similar substrates exist within the boundaries of Tracts 1 indicate the creek heelsplitter may exist within the Pike River segments of Tract 1. A qualitative review of these data indicates that Land Exchange Alternative B may result in the added presence of the creek heelsplitter.

Table 5.3.6-16 Eco-region SGCN Species Comparisons for Land Exchange Alternative B

SGCN Species	Common Name	Federal Land (Laurentian and Nawshauk Uplands)	Tract 1 (Nawshauk Uplands only)
Fish			
Ichthyomyzon fossor	brook lamprey	X	X
Mussels			
Lasmigona compressa	creek heelsplitter	X	X
Ligumia recta	black sandshell	X	X
Total species		3	3

Adopted from Section 4.3.6.

5.3.6.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing aquatic resources on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS responsibility for managing aquatic resources and would result in no further effects on existing aquatic species or habitats.

Fish and other aquatic life on the federal lands 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 from existing conditions, although it is expected that the water quality of the Embarrass River may improve as a result of corrective actions potentially required by the reissuance of existing NPDES/SDS permits in the NorthMet Project area. Future actions conducted under the Cliffs Erie Consent Decree may also change these conditions.

The non-federal lands would not go into USFS ownership, and land use would be determined by the private land owners. Effects to aquatic resources are difficult to predict given the uncertainty of future potential land use. Some lands may be developed, resulting in potential effects to aquatic species at the individual and local population levels, decreases in habitat, and adverse effects on habitat connectivity.

5.3.7 Air Quality

Because there are no current operations or activities on the non-federal parcels that would result in a change to ambient air quality, the Land Exchange Proposed Action (and alternatives) would not result in new effects on the federal estate. Indirect effects from the NorthMet Project Proposed Action on the non-federal parcels are considered under Class I area modeling and are discussed in Section 5.2.7.

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5.3.8 Noise and Vibration

Evaluation of potential noise, vibration, and airblast effects in the areas of the Land Exchange Proposed Action used the same methodologies and criteria that were described previously for the NorthMet Project Proposed Action. The results of the modeling indicate that noise, vibration, and airblast levels that would be experienced at or by sensitive receptors would be below the Minnesota standards. Therefore, operations at the Mine Site and Plant Site would not have a significant effect on human receptors within the federal and non-federal lands, including people that may use the non-federal lands for recreational activities such as hunting and hiking (if the Land Exchange Proposed Action were to occur and the non-federal lands were added to the Superior National Forest). The non-federal land tracts are approximately 10 to 90 miles from operations at the Mine Site and Plant Site; tracts located 50 to 90 miles away from the federal lands are outside the area of analysis for noise modeling and would be not affected by noise from operations at the Mine Site and Plant Site.

5.3.8.1 Methodology and Evaluation Criteria

The noise and vibration impact assessment area for the Land Exchange Proposed Action would involve transferring 6,495.4 acres of federal lands from public to private ownership, and up to 7,075.0 acres of land from private to public ownership. The spatial and temporal area of analysis assessed for noise, vibration, and airblast as part of the Land Exchange Proposed Action included the indirect effects resulting from the mining activities; therefore, the area of analysis is the same as that described in Section 5.2.8.1. As indicated before, three desktop computer models (ISO 9613-2 sound-propagation model, the Site Law formula, and the Terrock model) were used to evaluate noise, ground vibration, and airblast effects, respectively, on the federal and non-federal lands.

5.3.8.2 Land Exchange Proposed Action

5.3.8.2.1 Federal Lands

The topography and land cover of the federal lands are similar to those of the Mine Site previously discussed, but include additional area to the west and northwest that are mostly wetland. NorthMet Project Proposed Action-related activities that would result in noise, vibration, or airblast would not occur on the additional federal lands (3,776.1 acres) situated west and northwest of the Mine Site, so no additional noise, vibration, or airblast effects would occur in this area. It should be noted that the federal land excludes private lands (295.2 acres) situated south of Dunka Road. There are no residential areas or isolated houses within the federal lands that could be affected by the NorthMet Project Proposed Action’s noise and vibration-related activities (Figures 5.3.8-1 to 5.3.8-4). As discussed in Section 5.2.8.2, noise and vibration levels from the Mine Site would be too low to significantly affect the recreational use of the federal land (i.e., minor effects within 0.84- to 1-mile radius of the Mine Site).

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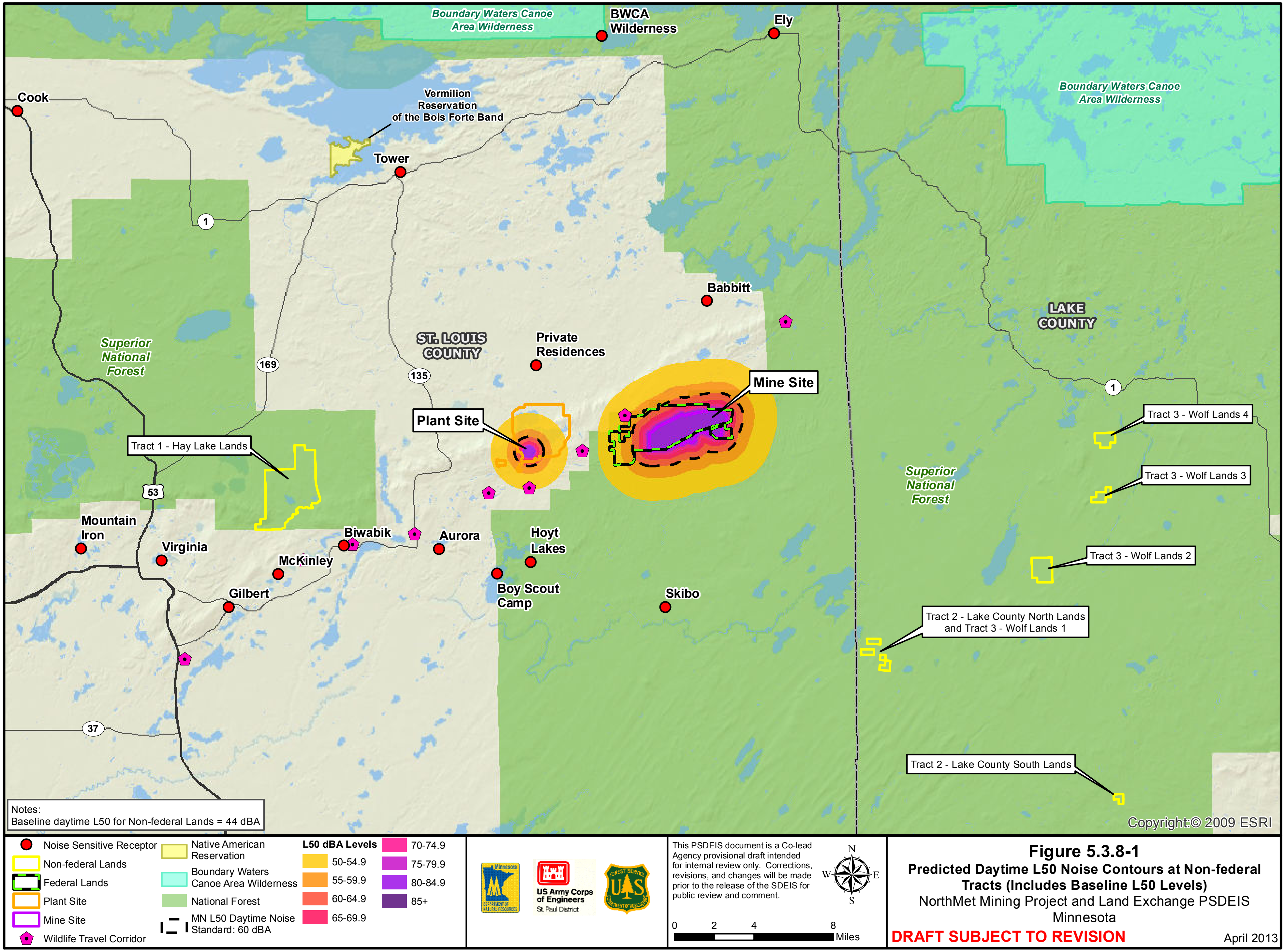

This PSDEIS document is a Co-lead Agency provisional draft intended for internal review only. Corrections, revisions, and changes will be made prior to the release of the SDEIS for public review and comment.

Figure 5.3.8-1
Predicted Daytime L50 Noise Contours at Non-federal Tracts (Includes Baseline L50 Levels)
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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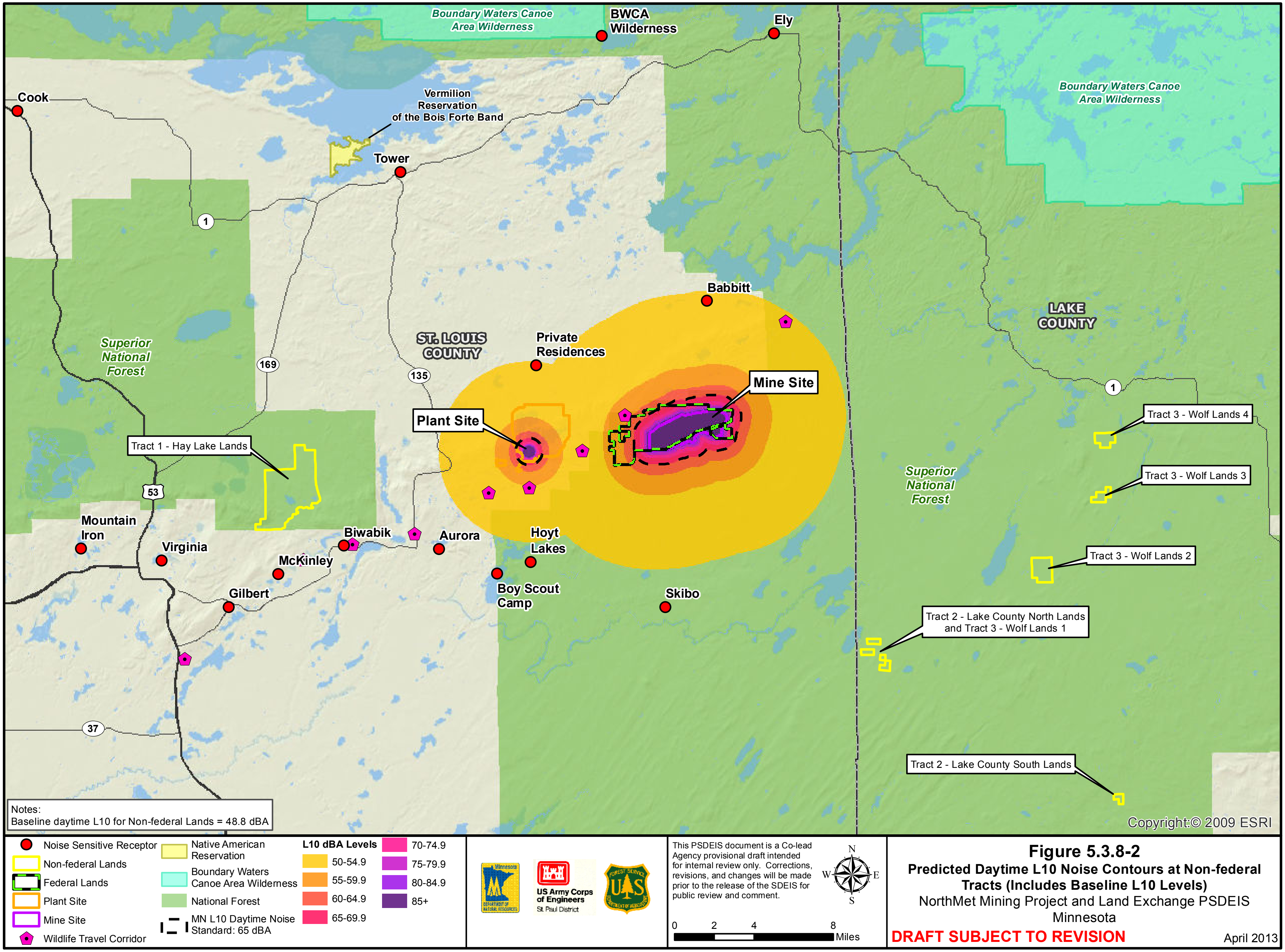

Figure 5.3.8-2
Predicted Daytime L10 Noise Contours at Non-federal Tracts (Includes Baseline L10 Levels)
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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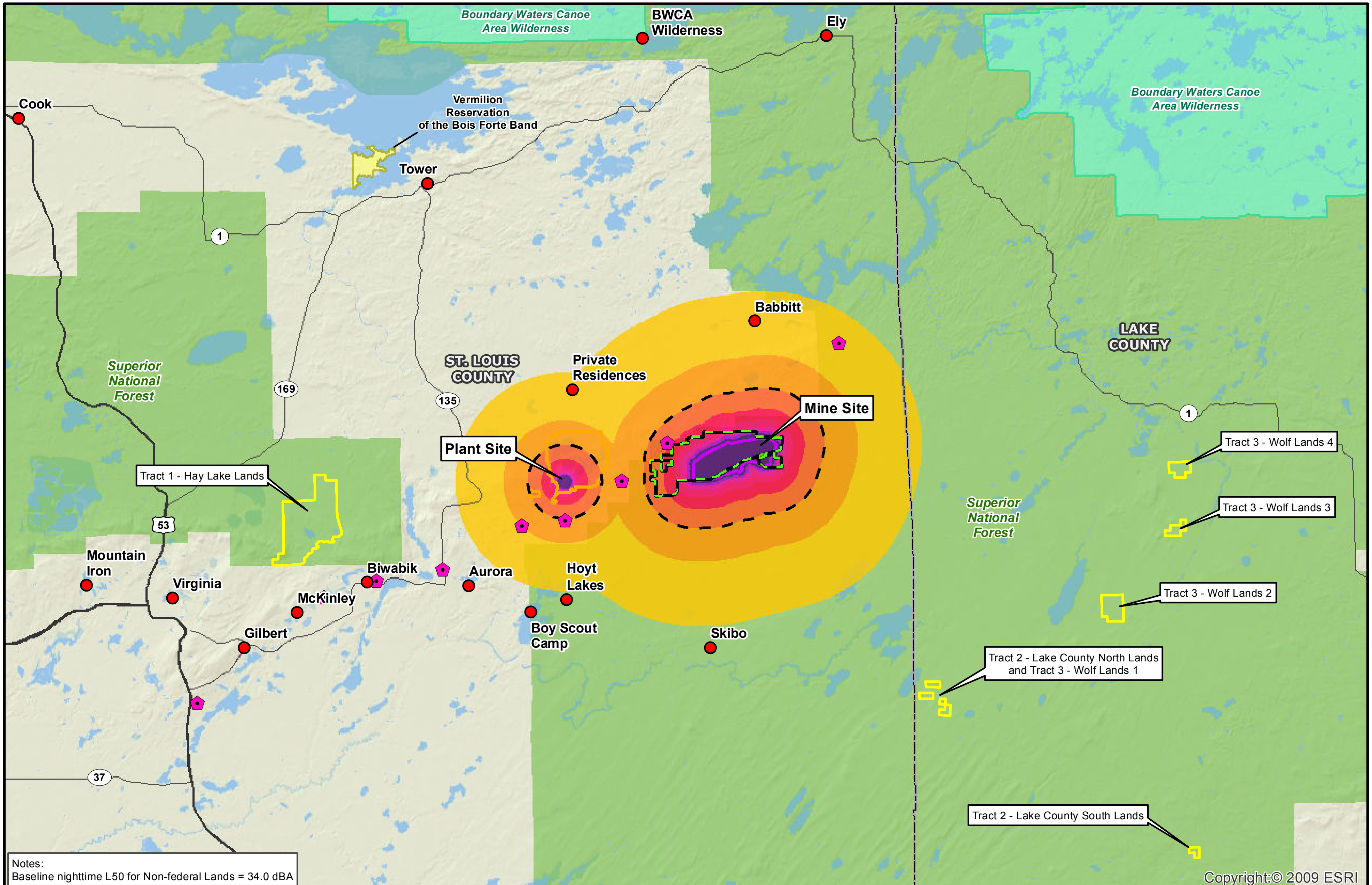

Notes:
Baseline nighttime L50 for Non-federal Lands = 34.0 dBA

Noise Sensitive Receptor
Non-federal Lands
Federal Lands
Plant Site
Mine Site
Wildlife Travel Corridor
Native American Reservation
Boundary Waters Canoe Area Wilderness
National Forest
MN L50 Nighttime Noise Standard: 50 dBA

L50 dBA Levels
40-44.9
45-49.9
50-54.9
55-59.9
60-64.9
65-69.9
70-74.9
75+

US Army Corps of Engineers St. Paul District

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N W E S

0 2 4 8 Miles

Figure 5.3.8-3

Predicted Nighttime L50 Noise Contours at Non-federal Tracts (Includes Baseline L50 Levels)

NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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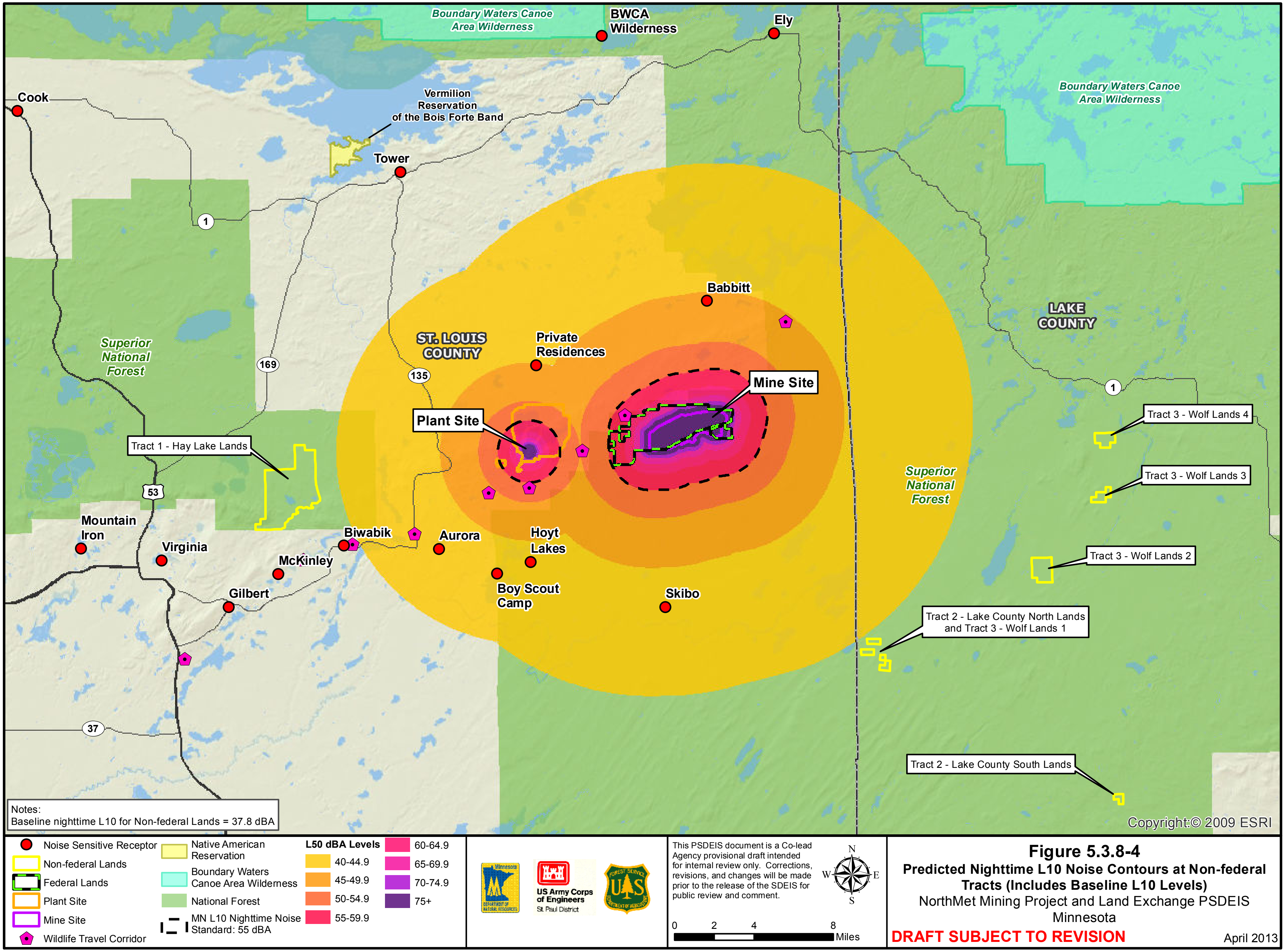

Figure 5.3.8-4

Predicted Nighttime L10 Noise Contours at Non-federal Tracts (Includes Baseline L10 Levels)

NorthMet Mining Project and Land Exchange PSDEIS

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5.3.8.2.2 Non-federal Lands

The non-federal lands would be managed consistent with the adjacent forest lands management (see Section 4.3.1). No direct effects from the Land Exchange Proposed Action are anticipated since the USFS currently has no plans for operations on the non-federal lands and no NorthMet Project Proposed Action-related activity (e.g., drilling, blasting, excavation work, material haulage via trucks, and ore crushing) would occur within the non-federal lands.

Review of the most-up-to-date aerial maps indicates that there are no human or residential receptors within or adjacent to the non-federal lands (Tracts 1 to 5). If the Land Exchange Proposed Action were to occur and the non-federal lands were added to the Superior National Forest (i.e., if the tracts became federal lands), public recreational use such as hiking and hunting would likely occur on these tracts.

To determine the indirect effect of operations at the Mine Site and Plant Site on people that may use the non-federal lands for recreational activities such as hiking and hunting, the modeled area was expanded to a 20-mile radius from both the Mine Site and the Plant Site. Daytime and nighttime noise contours (L_{50} and L_{10}) generated from the modeling are shown in Figures 5.3.8-1 through 5.3.8-4. During the daytime, all potential receptors within the non-federal lands were outside the 50-dBA (L_{50} and L_{10}) noise contours. During the nighttime, all potential receptors within the non-federal lands were outside the 40-dBA (L_{50} and L_{10}) noise contours. The highest daytime noise levels, including baseline levels, that would be experienced at the closest non-federal lands were 40.0 dBA (L_{50}) and 43.8 dBA (L_{10}) at Tract 1. During the nighttime, the highest noise levels, including baseline levels, that would be experienced at the closest non-federal lands were 34.6 dBA (L_{50}) and 38.4 dBA (L_{10}) at Tract 1. This shows that the predicted daytime and nighttime noise levels at the non-federal lands due to operations at the Mine Site and Plant Site are well below Minnesota's noise standards. The results of the noise assessment indicate that operations at the Mine Site and Plant Site would add no perceptible noise (0 to 1 dBA) to the current baseline levels experienced at the non-federal lands. Non-federal Tracts 4 and 5 are approximately 50 and 90 miles away, respectively, from the federal lands and are outside the area of analysis for noise modeling; neither tract would be affected by noise from operations at the Mine Site and Plant Site.

Based on the information above, it is anticipated that noise from typical mining and hauling operations at the Mine Site and ore-crushing operations at the Plant Site would not affect the people that may use the non-federal lands for recreational activities such as hiking and hunting under the Land Exchange Proposed Action. The non-federal lands are far from the Mine Site and Plant Site (10 to 90 miles away), so indirect vibration levels from operations at both locations would not affect potential receptors within the non-federal lands that would be acquired under the Land Exchange Proposed Action.

5.3.8.3 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the transfer of lands would not occur and there would be no increase in noise and vibration levels at the federal and non-federal lands. Therefore, there would be no change in noise and vibration levels at the nearest receptors.

5.3.8.4 Land Exchange Alternative B

Under the Land Exchange Alternative B, 4,752.6 acres would be conveyed to PolyMet. The type, quantity, and location of noise- and vibration-related sources (i.e., drilling, blasting, excavation work, haul trucks, trains, and crushers) for the Land Exchange Alternative B would be the same as that for the Land Exchange Proposed Action. Therefore, the Land Exchange Alternative B would not change noise and vibration levels experienced at the federal lands or modify noise and vibration effects on nearest receptors. If the 4,752.6 acres of land were to become privately owned, public recreational use currently associated with the smaller federal parcel would no longer occur on that portion of the federal lands (i.e., the Land Exchange Alternative B would have no effects associated with public recreational use on that portion). Sections 5.2.8.2.1 and 5.2.8.2.2 provide a discussion of the noise and vibration effects on the federal lands.

Under the Land Exchange Alternative B, Tract 1 (4,926.3 acres) would be acquired by the USFS. The type, quantity, and location of noise- and vibration-related sources (i.e., drilling, blasting, excavation work, haul trucks, trains, and crushers) for this alternative would be the same as that for the Land Exchange Proposed Action. Therefore, the Land Exchange Alternative B would not change noise and vibration levels experienced at the non-federal lands or modify noise and vibration effects on the nearest receptors.

As indicated above, during the daytime, all modeled potential receptors within Tract 1 were outside the 50-dBA (L_{50} and L_{10}) noise contours (Figure 5.3.8-1 and 5.3.8-2). Similarly, during the nighttime, all potential receptors within Tract 1 were outside the 40-dBA (L_{50} and L_{10}) noise contours (Figure 5.3.8-3 and 5.3.8-4). The highest daytime noise levels, including baseline levels, that would be experienced at Tract 1 would be 40.0 dBA (L_{50}) and 43.8 dBA (L_{10}). During the nighttime, the highest noise levels, including baseline levels, that would be experienced at Tract 1 would be 34.6 dBA (L_{50}) and 38.4 dBA (L_{10}). The predicted daytime and nighttime noise levels at Tract 1 due to operations at the Mine Site and Plant Site are well below Minnesota’s noise standards. The results of the noise assessment indicate that operations at the Mine Site and Plant Site would add little to no additional noise (0 to 1 dBA) to the current baseline levels experienced at Tract 1.

5.3.9 Cultural Resources

This section describes the environmental consequences of the Land Exchange Proposed Action on historic properties that are present on the federal and non-federal lands. Under the Land Exchange Proposed Action and alternatives, the Superior National Forest would retain its ongoing responsibility for managing cultural resources on Superior National Forest lands in accordance with the Forest Plan. At this time, environmental consequences on historic properties have not been completed. Results will be added to this document when received from the federal Co-lead Agencies.

5.3.9.1 Methodology and Evaluation Criteria

Effects associated with the Land Exchange Proposed Action would be the potential destruction of historic properties and the loss of the historic information and cultural significance that these properties could represent. An additional effect would be the loss of federal protection for any unknown historic properties, such as those provided under the NHPA, the Archaeological Resource Protection Act, and the Native American Graves and Repatriation Act. The methodology and evaluation criteria used to determine potential effects on cultural resources from the Land Exchange Proposed Action are similar to those used for the NorthMet Project Proposed Action (Section 5.2.9).

The analysis of cultural resources was performed based on readily available information, and no additional field work was performed. Intensive analysis is only needed for the federal parcel leaving federal ownership. The non-federal lands that would be going into federal ownership would not be of primary concern since future management of these lands would be per Forest Plan direction for heritage resources.

The spatial area of analysis for Land Exchange Proposed Action effects on cultural resources included the boundaries of the federal tracts proposed for the exchange, while the temporal area of analysis was the point in time at which the change in ownership would occur. The geographic extent is appropriate because it includes all cultural resources that would be affected by a change in site protection. In a temporal sense, the change in ownership is appropriate because this is when there would be a gain or loss of legal protections.

The analysis of the cultural resources affected by the Land Exchange Proposed Action was guided by effects criteria that were developed by the USFS and the USACE. The analysis included a review of known and recorded heritage resources (i.e., historic structures, artifacts, traditional cultural properties) within or immediately adjacent to the federal and non-federal lands and a qualitative assessment to determine if there were portions of the federal and non-federal lands that have not been surveyed previously and would have a high probability to yield heritage resources.

5.3.9.2 Land Exchange Proposed Action

5.3.9.2.1 Federal Lands

The cultural resources analysis has not been completed at this time; however, the federal Co-lead Agencies are currently working with the SHPO and the Bands to make final determinations and will present the results of the effects and appropriate mitigation in the FEIS.

Cultural resources located on private lands being transferred to federal ownership would not be considered as adversely affected, but would be considered to have greater preservation protection under federal law.

The 1854 Treaty resources located within the Land Exchange Proposed Action would be similar to the Mine Site portion of the NorthMet Project area previously discussed in Section 4.2.9. Section 4.2.9 provides further discussion of the existing conditions on the Mine Site and associated federal lands. The Land Exchange Proposed Action represents an exchange of private and federal land, but it is also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19th Century. Due to the nature of a land exchange, therefore, the effects would be limited to access to such resources versus direct or indirect effects, as would be the case with the Land Exchange Proposed Action.

An analysis of effects to 1854 Treaty resources, as described and discussed in Section 4.2.9, is limited by the lack of available information concerning the use of such resources. Determining how the Bands have traditionally conducted their usufructuary rights on or near the Land Exchange Proposed Action area would only be available through a detailed ethnographic study of individual Band members and their families. The cultural resources investigations included Band member interviews with Bois Forte, Fond du Lac, and Grand Portage, although only Bois Forte's results were made available. The results of the interviews and the cultural resources investigation did not find any natural resources that would be considered a TCP or other traditional cultural place.

There is also no quantitative analysis of current use of treaty resources in or near the Land Exchange Proposed Action area. This lack of data also precludes the analysis of how Band members would be quantitatively affected socioeconomically by effects on 1854 Treaty resources, further discussed in Section 5.2.10. The primary source of data for assessing effects on treaty resources is from the analysis of the environment in other chapters of this SDEIS as discussed in Section 4.2.9.4 and 5.2.9.2.2.

As discussed above, the Land Exchange Proposed Action could have effects on 1854 Treaty resources—i.e., lack of access to those areas and species that are traditionally or culturally important to the Bands. Band members' use of the Land Exchange Proposed Action area is not well-defined through research at this time and did not emerge through interviews. A good faith effort was made on the part of the federal Co-lead Agencies to identify use areas in or adjacent to the Land Exchange Proposed Action area; however, those efforts resulted in little specific information concerning historic subsistence use and no information regarding recent subsistence activity within the Land Exchange Proposed Action area. As such, cultural effects on the Bands would be difficult to quantify in regards to such incremental increases below standards or effects to species where appropriate mitigation is used.

5.3.9.2.2 Non-federal Lands

There are no known cultural resources on the non-federal lands. Cultural resources located on private lands being transferred to federal ownership would not be considered adversely affected, but would be considered to have greater preservation protection under federal law.

The Land Exchange Proposed Action represents an exchange of private and federal land, but it also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19th Century. Due to the nature of a land exchange, therefore, the 1854 Treaty resources would be available for resource gathering and subsistence use by the Bands and would receive greater protection under federal law than they are currently receiving.

5.3.9.3 Land Exchange No Action Alternative

There would be no effects to cultural resources or 1854 treaty resources within the Land Exchange No Action Alternative.

5.3.9.4 Land Exchange Alternative B

5.3.9.4.1 Federal Lands

All of the cultural resources and 1854 Treaty resources identified and discussed in Section 5.3.9 are located within the Land Exchange Alternative B. Effects to these resources would be the same as discussed in Section 5.3.9.

5.3.9.4.2 Non-federal Lands

There are no known cultural resources on the non-federal lands. Cultural resources located on private lands being transferred to federal ownership would not be considered adversely affected, but would be considered to have greater preservation protection under federal law.

The Land Exchange Alternative B represents an exchange of private and federal land, but it also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19th Century. Due to the nature of a land exchange, therefore, the 1854 Treaty resources would be available for resource gathering and subsistence use by the Bands and would receive greater protection under federal law than they are currently receiving.

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5.3.10 Socioeconomics

This section describes the potential socioeconomic consequences of the Land Exchange Proposed Action. Overall, the Land Exchange Proposed Action would have the following socioeconomic effects:

- positive economic effects due to the value of forestry products made available on the non-federal lands, as well as jobs and revenue due to increased visitation of the non-federal lands;
- positive effects for EJ populations and subsistence activities, due to the net increase in available land for subsistence activities; and
- negligible effects on other socioeconomic considerations.

5.3.10.1 Methodology and Evaluation Criteria

As discussed in Section 5.2.10, the study area for socioeconomics differs from the study area used for much of the rest of the SDEIS. It includes Cook, Lake, and St. Louis counties. This includes, where appropriate, the St. Louis County municipalities listed in Section 4.2.10. The primary issues related to socioeconomics on and near the non-federal lands, and, therefore, the potential for effects, would include the following:

- the amount of annual property taxes lost to the county from non-federal lands going to federal ownership;
- the potential change in payment in lieu of taxes to the county from the Land Exchange Proposed Action;
- the differences in assessed market values of federal lands compared to non-federal lands proposed for exchange;
- the difference between present values of recently harvested (past 10 years) products from the federal parcels and the value of products from the federal parcels;
- the difference between present and future values of potential forest products in Land Exchange Proposed Action parcels;
- the change in forestry employment on federal and non-federal parcels (estimated);
- a qualitative assessment of public visitation to the federal tract and estimated/potential visitation to non-federal tracts;
- the difference between present and future estimated spending on recreational tourism;
- the difference between present and future amounts of treaty resources in Land Exchange Proposed Action parcels; and
- a qualitative assessment of tribal use of the federal parcels and estimated/potential use of the non-federal parcels.

5.3.10.2 Land Exchange Proposed Action

This section describes the potential socioeconomic effects of the Land Exchange Proposed Action on communities in the socioeconomics study area. The Land Exchange Proposed Action would create moderate positive economic effects through increased opportunity for forestry and recreation and associated employment, earnings, and revenue. The Land Exchange Proposed Action would have negligible negative effects on other socioeconomic factors, including housing, public facilities and services, EJ populations, and subsistence.

5.3.10.2.1 Economic Activity

There is no current economic activity (e.g., forestry, etc.) on the federal lands, although harvesting of forest products is permitted by the Forest Plan. More importantly, the federal lands are not accessible to the public for economically measurable use, such as forestry or recreation (see Section 5.2.11). Thus, while the federal lands may hold some theoretical economic value for timber harvest, their practical economic value is zero. Table 5.3.10-1 lists data and observations relevant to the economic value of the federal and non-federal lands.

Tax Payments

Implementation of the Land Exchange Proposed Action would transfer ownership of the federal lands to PolyMet, and would result in an active mining operation that would generate federal, state, and local tax revenue, in addition to employment. As described in Section 5.2.10.2.3, total annual direct tax payments from the NorthMet Project Proposed Action during operations are expected to be approximately $8 to $16 million (equating to up to $69 million annually when including indirect and induced tax payments), a positive economic effect, both on an absolute basis and when compared with the minimal current economic activity within the NorthMet Project area.

The amount of property taxes that would be paid to St. Louis County for the federal lands has not yet been determined; however, property taxes would be included in the overall taxes paid by PolyMet, shown in Table 5.2.10-3. For the non-federal lands, increases to federal payments in lieu of taxes to study area counties as a result of the Land Exchange Proposed Action would be negligible (compared to the current payment in lieu for the federal lands).

Table 5.3.10-1 Economic Value of Federal and Non-federal Lands (in 2012 dollars)

Land	Acreage	Annual Property Tax[1]	Annual Payment in Lieu of Taxes (PILT)[2]	Market Value of Land[3]	Other Economic Value
Federal Lands	6495.4	NA[3]	$2,273.39	TBD	NA
Tract 1	4,926.0	$20,714.68	$1,724.10	TBD	Potential recreational value due to the presence of Hay Lake (boating, fishing), existing trails, evidence of ongoing hunting, and other recreational activity (see Section 4.3.11).
Tract 2	382.0	$2,563.54	$133.70	TBD	NA
Tract 3	1,576.0	Unknown	$551.60	TBD	NA
Tract 4	160.0	$739.30	$56.00	TBD	NA
Tract 5	31.0	$1,938.00	$10.85	TBD	Potential recreational value. Former site of a cabin and camp site owned by Carleton College. Adjacent to highly scenic MacFarland Lake (boating, fishing, access to BWCAW) (see Section 4.3.11).
Subtotal, Non-Federal Lands	7,075.0	$25,995.52	$2,476.25	TBD	NA
Net Change[5]	**579.6**	**NA**	**$202.86**	**TBD**	**NA**

1 Source: Orehek, PolyMet, pers.comm., April 17, 2012.
2 Source: DOI 2012
3 See Market Value section below.
4 Table 5.2.10-3 describes total estimated taxes that PolyMet expects to pay for the federal lands. The amount specifically anticipated for property taxes has not been determined.
5 Calculated as (non-federal) minus (federal).

Market Value

Federal regulations governing land exchanges, contained in 36 CFR 254.12, require that the assessed value of non-federal land being exchanged be equal to or within 25 percent of the assessed value of the federal land being exchanged. Assessment data will be updated and included in the FEIS.

Recreation Value

Recreation in national forests can generate direct revenue to the USFS and the state in the form of entry fees and hunting and fishing license fees, as well as via indirect economic activity related to the multiplier effect of such activity (e.g., purchase of fishing tackle and bait). This economic activity, in turn, would create some additional employment (or further sustain existing forestry- and recreation-based jobs) throughout the study area.

In 2006 (the most recent year for which data are available), there were approximately 1,376,000 recreational visits to Superior National Forest (USFS 2012). "Recreational," as used in USFS 2010, is very broadly defined, and primarily distinguishes (and excludes) transient visitors such as commuters or restroom visits. On average, visitors to the forest spent $643 per visiting party per day (i.e., the group participating in the visit, such as a family).

Tracts 1 and 5 also have the potential for recreational use (whereas the federal lands are not easily accessible for any purpose). To the degree that the USFS manages these lands (and the other non-federal lands) for active recreational activity, the Land Exchange Proposed Action could increase economic activity associated with recreation and tourism. The non-federal lands comprise less than half of 1 percent of the 2,172,764 acres of Superior National Forest that are managed by USFS, so any such increase would be small.

Timber

There is no ongoing forestry activity on the federal lands, and no evidence of recent past forestry activity. Portions of Tracts 2, 3, and 4 show some evidence of timber harvesting, and a timber harvest agreement is in place through 2013 for the Wolf Lands 3 parcel (see Section 4.3.1). Likely USFS management area designations for the non-federal lands would allow timber harvesting on 6,547.1 acres of the non-federal lands (the lands designated General Forest or General Forest – Longer Rotation; see Table 5.3.1-1). Thus, the Land Exchange Proposed Action could increase timber production in Superior National Forest.

On average, 1 percent of timber land in Superior National Forest is harvested each year, with an estimated value of $400 (gross) per harvested acre (Deckard 2012). Timber harvesting on 1 percent of the non-federal lands would therefore generate gross proceeds of approximately $26,188 per year. This represents approximately 2 percent of the $1,435,900 value of timber harvests in Superior National Forest in 2011 (Deckard 2012). This additional activity would be estimated to generate fewer than 20 new jobs in the region. Minnesota averages approximately one forestry job (including logging and primary manufacturing) per 350 acres of annual harvest, and each direct forestry job generates another 3.6 indirect and induced jobs (Deckard 2012). Using these estimates, the Land Exchange Proposed Action could generate four direct and 12 indirect jobs. As of 2009, forestry activities employed approximately 1,287 individuals in the study area (Headwaters Economics 2009).

Environmental Justice and Subsistence

Potential EJ populations, as well as the EJ and subsistence effects of the Land Exchange Proposed Action on the federal lands, are described in Section 5.2.10.2.7. Although tribal entities possess usufructuary rights to hunt, fish, and gather throughout the 1854 Ceded Territory, the federal lands are not easily accessible for such subsistence activities. The Land Exchange Proposed Action would involve the transfer of 6,495.4 acres of inaccessible federal lands from public to private ownership, and up to approximately 7,075 acres of publicly accessible land from private to public ownership. To the degree that increased availability of publicly accessible land improves property value and generates revenue (see above) in the study area, the Land Exchange Proposed Action could have positive effects on EJ populations.

In addition, the previously private non-federal lands (where there is no evidence of subsistence activity and little public access) would become available without exception for subsistence activities. Resource-specific sections of the SDEIS address the degree to which subsistence species and resources are likely to be available on the non-federal lands. However, the additional public lands in and of themselves would be a positive effect on subsistence activities.

Other Socioeconomic Considerations

The Land Exchange Proposed Action would result in slight increases in demand for public safety services to assist recreational or other users of the non-federal lands. This is a demand that currently does not exist on the inaccessible federal lands. The non-federal lands represent 0.2 percent of the Superior National Forest. Thus, any such increased demand would be marginal. No new housing (and thus no increased demand for educational facilities) is anticipated on the non-federal lands. Any utilities extended to the non-federal lands (such as electricity) would likely be minimal in nature (given the ROS categories assigned to the non-federal lands—see Section 5.3.11). Thus, the Land Exchange Proposed Action would have negligible effects on other socioeconomic considerations.

The Land Exchange Proposed Action would result in a loss of some of the ecosystem services provided by the forest, wetland, and other natural habitats on the federal lands, particularly the portions of the federal lands (i.e., the Mine Site) where habitat would be replaced by mine facilities. Some of these services could be restored during the post-closure period, when the federal lands (as well as the Plant Site) are revegetated. In exchange, the Land Exchange Proposed Action would enable the USFS to directly manage the ecosystems services on the non-federal lands.

5.3.10.3 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the NorthMet Project Proposed Action would not be developed, there would be no change to the federal lands, and the non-federal lands would remain inaccessible to the public (including tribal entities). Given other private ownership (e.g., the Dunka Road and railroad), the federal and non-federal lands would remain generally inaccessible to the public. Therefore, there would be no direct or indirect effects on socioeconomics.

5.3.10.4 Land Exchange Alternative B

Under the Land Exchange Alternative B, approximately 4,753 acres of federal lands would be exchanged for the 4,926-acre Tract 1. The remainder of the federal lands would remain inaccessible by land. The Land Exchange Alternative B would generate economic benefits through forestry and recreational activities (see Table 5.3.10-1); however, these benefits would be less than from the Land Exchange Proposed Action. Similarly, the Land Exchange Alternative B would create benefits for EJ and subsistence activities, although less so than the Land Exchange Proposed Action. Negative socioeconomic effects from the Land Exchange Alternative B would be minimal.

5.3.11 Recreation and Visual Resources

This section describes the potential environmental consequences of the Land Exchange Proposed Action on recreational facilities and activities that typically take place on the federal and non-federal lands. In this section, effects on the federal and non-federal lands are discussed together, to facilitate calculation of net changes in recreation and scenic classes. Under the Land Exchange Proposed Action and Land Exchange Alternative B, the Superior National Forest would retain its ongoing responsibility for managing recreational resources on National Forest System lands in accordance with the Forest Plan.

Overall, the Land Exchange Proposed Action would increase opportunities for recreational activity through the acquisition of up to approximately 7,075.0 acres of publicly accessible land (the non-federal lands) in exchange for 6,495.4 acres of federal land that are not publicly accessible, and thus cannot be used for recreation. The Land Exchange Proposed Action would also increase the amount of land controlled by the USFS in the Superior National Forest with Moderate and High SIOs.

The Land Exchange Alternative B would have a lesser degree of the same type of benefits for recreation and visual resources as the Land Exchange Proposed Action, due to the reduced land area involved.

Table 5.3.11-1 shows the effects of the Land Exchange Proposed Action and the Land Exchange Alternative B on acreage of various ROS classes; Table 5.3.11-2 shows the effects on SIO classes.

Table 5.3.11-1 Net Increase or Decrease of Recreation Opportunity Spectrum Classes

	Increase (Decrease) of ROS Class (Acres)			
Alternative	**Semi-Primitive Motorized**	**Semi-Primitive Non-Motorized**	**Roaded Natural**	**Total**
Land Exchange Proposed Action	(2,243.5)	2,309.9	513.2	579.6
Land Exchange Alternative B	(2,972.8)	2,162.2	984.3	173.7

Table 5.3.11-2 Net Increase or Decrease of Scenic Integrity Objectives

	Increase (Decrease) of Scenic Integrity Objective (Acres)			
Alternative	**High**	**Moderate**	**Low[1]**	**Total**
Land Exchange Proposed Action	136.1	1,644.5	(1,201.0)	579.6
Land Exchange Alternative B	20.3	1,315.3	(1,161.9)	173.7

Notes:
1 Includes open water (e.g., Mud Lake) that is not assigned a SIO.

5.3.11.1 Methodology and Evaluation Criteria

5.3.11.1.1 Recreation

The primary issues related to recreational facilities and activities associated with the Land Exchange Proposed Action on and near the federal lands and non-federal lands include the following:

- change in areas of ROS classes within the Superior National Forest; and
- qualitative difference in recreation opportunities, as measured using ROS classes, between outgoing federal land and non-federal lands to be acquired.

ROS classes were defined by the USFS (1982) and ROS classes for the non-federal lands were mapped to match the existing mapped ROS Spectrum areas on surrounding adjacent federal lands. GIS analysis was employed to determine the net change in acreage by ROS class. ROS classes are discussed in section 4.2.11.1.1.

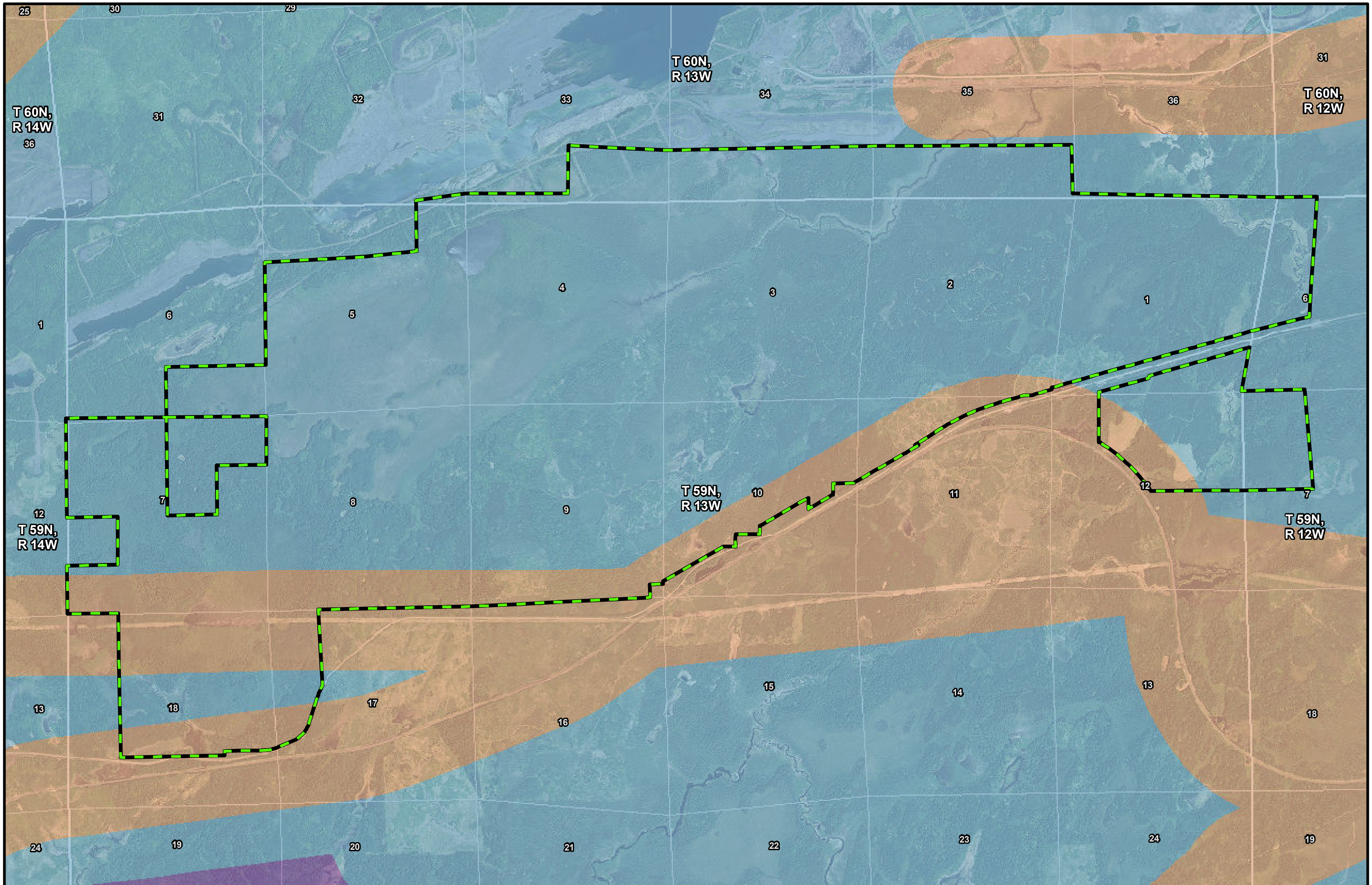
5.3.11.1.2 Visual Resources

The primary issue related to visual resources on and near the non-federal lands is the change in acreage of High, Moderate, and Low SIO classified land within Superior National Forest lands. SIOs were provided by USFS (1995), and as with ROS classes, SIOs for the non-federal lands were mapped to match the existing mapped SIOs on surrounding adjacent federal lands. GIS analysis was employed to determine the net change in acreage by SIO. SIOs are discussed in section 4.2.11.1.2. This quantitative analysis was supplemented by a qualitative description of loss of scenery opportunities on federal lands that would be conveyed to PolyMet and the gain of scenery opportunities on non-federal lands to be acquired and managed by USFS.

5.3.11.2 Land Exchange Proposed Action

5.3.11.2.1 Recreation

ROS classes for the federal lands are shown on Figure 5.3.11-1; the classes that would be applied to the non-federal lands are also shown on Figures 5.3.11-2 and 5.3.11-3. These classifications are summarized in Table 5.3.11-3. The federal lands in the Land Exchange Proposed Action consist of 967.0 acres designated as Roaded Natural and 5,528.4 acres designated Semi-Primitive Motorized (see Table 5.3.11-3). As described in Sections 4.2.11 and 4.3.11, the Semi-Primitive (Motorized and Non-Motorized) classes indicate areas where interaction between visitors is rare, but where human activities may be visible. The Roaded Natural class indicates an area where evidence of human activity and interactions are more frequent, and occasionally prevalent.



Federal Lands
Section Boundary
Section Label
Recreation Opportunity Spectrum
Semi-Primitive Motorized
Semi-Primitive Non-motorized
Primitive
Roaded Natural
Rural
Urban

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US Army Corps of Engineers St. Paul District

Figure 5.3.11-1
Recreation Opportunity Spectrum
Federal Lands
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota
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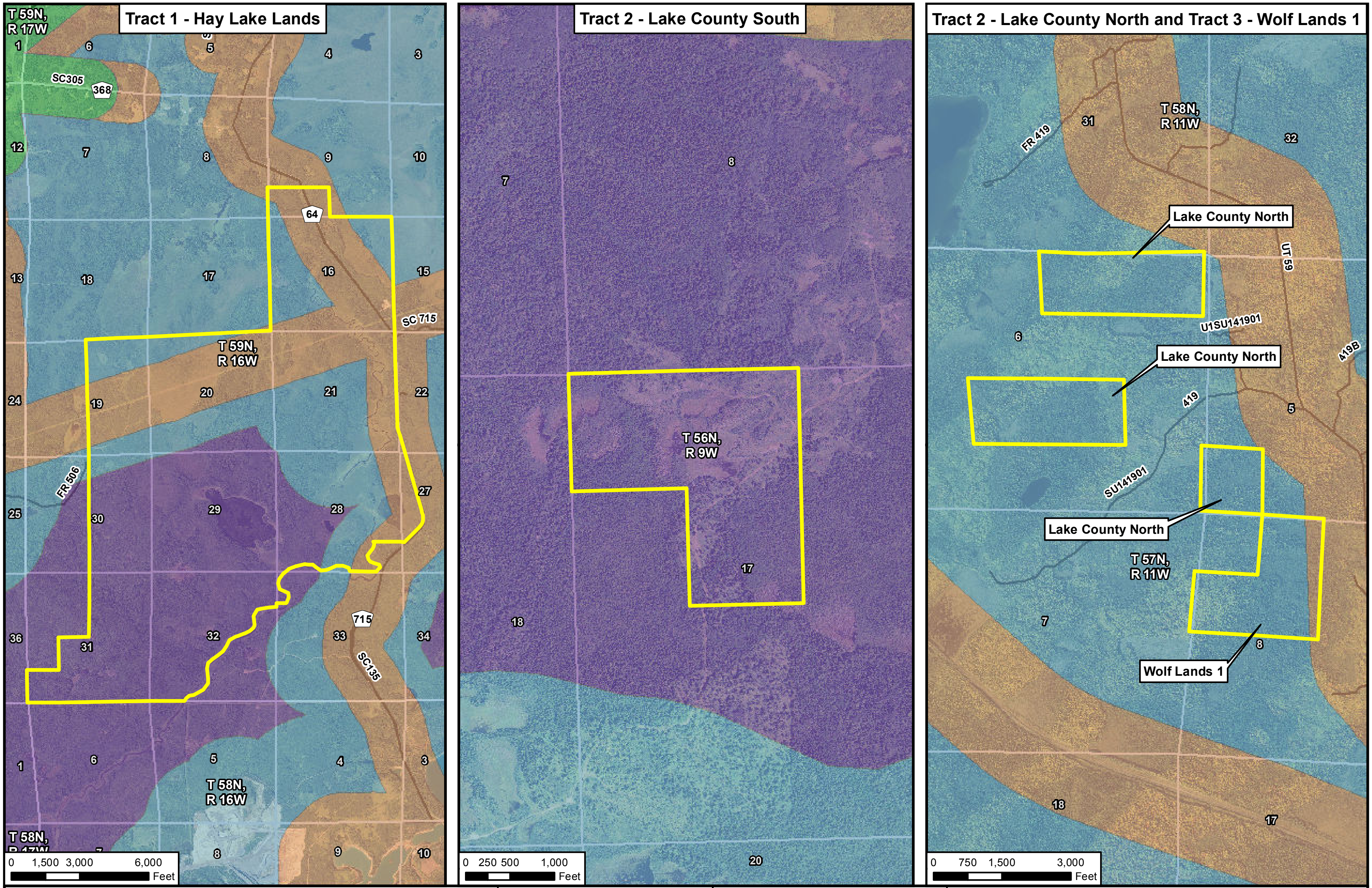

Non-federal Lands

Section Boundary

1 Section Label

Recreation Opportunity Spectrum

Semi-Primitive Motorized

Semi-Primitive Non-motorized

Primitive

Roaded Natural

Rural

Urban

US Army Corps of Engineers St. Paul District

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N W E S

Figure 5.3.11-2

Recreation Opportunity Spectrum

Tracts 1, 2 and 3

NorthMet Mining Project and Land Exchange PSDEIS

Minnesota

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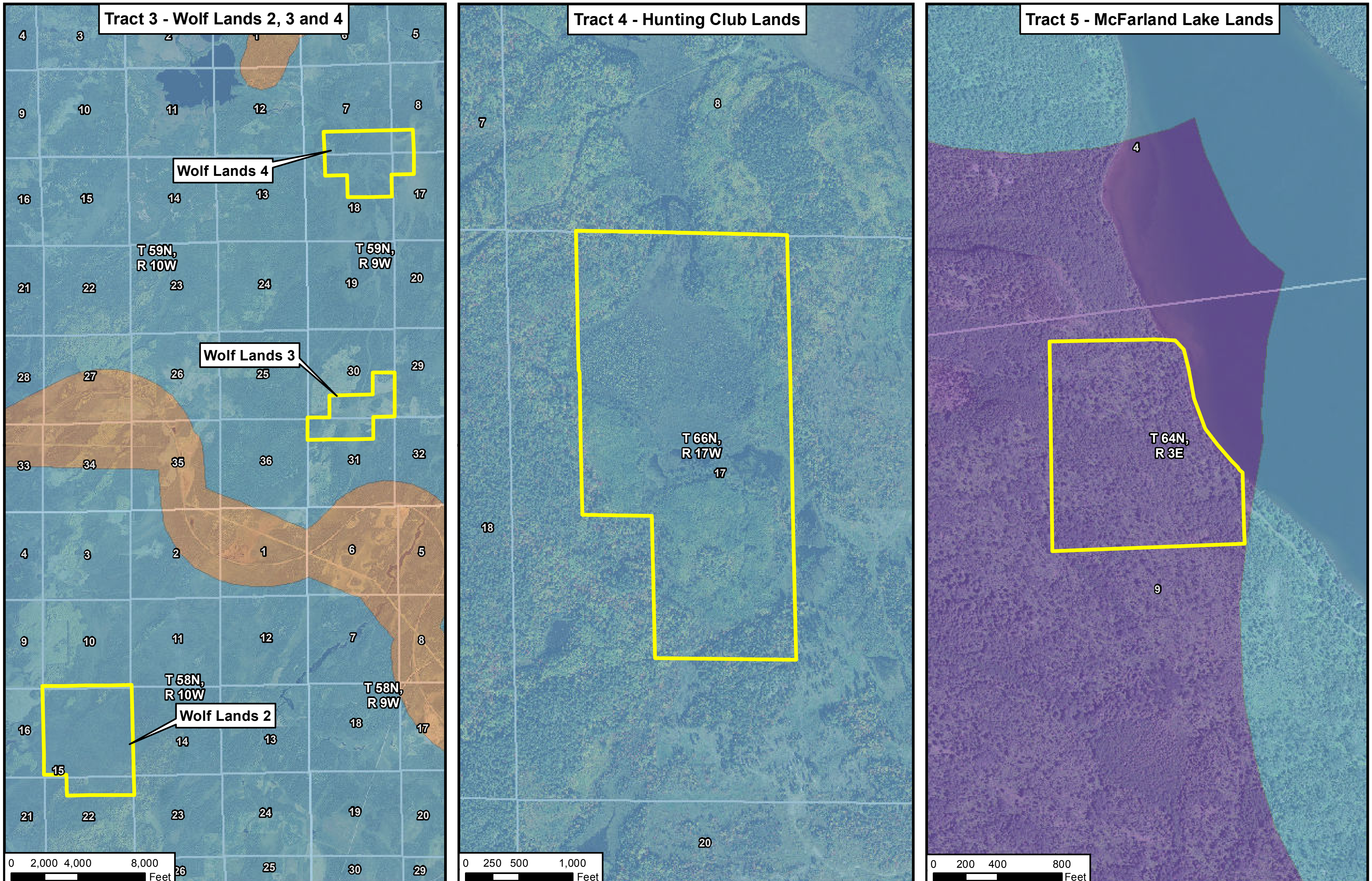

Non-federal Lands
Section Boundary
Section Label
Recreation Opportunity Spectrum
Semi-Primitive Motorized
Semi-Primitive Non-motorized
Primitive
Roaded Natural
Rural
Urban

US Army Corps of Engineers
St. Paul District

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N W E S

Figure 5.3.11-3
Recreation Opportunity Spectrum
Tracts 3, 4 and 5
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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Table 5.3.11-3 Recreation Opportunity Spectrum Classifications of Federal and Non-Federal Lands (Land Exchange Proposed Action)

	Acres of ROS Class			
Parcel	**Semi-Primitive Motorized**	**Semi-Primitive Non-Motorized**	**Roaded Natural**	**Total**
Lands Conveyed				
Federal lands	5,528.4	0.0	967.0	6,495.4
Lands Acquired				
Tract 1 - Hay Lake	1,303.8	2,162.2	1,460.3	4,926.3
Tract 2 - Lake County North	265.0	0.0	0.0	265.0
Tract 2 - Lake County South	0.0	116.9	0.0	116.9
Tract 3 - Wolf Land 1	106.1	0.0	19.7	125.8
Tract 3 - Wolf Land 2	767.9	0.0	0.0	767.9
Tract 3 - Wolf Land 3	277.4	0.0	0.0	277.4
Tract 3 - Wolf Land 4	404.7	0.0	0.0	404.7
Tract 4 - Hunting Club	160.2	0.0	0.0	160.2
Tract 5 – McFarland Lake	0.0	30.8	0.0	30.8
Subtotal: non-federal lands	3,285.1	2,319.9	1,480.0	7,075.0
Net Change				
Net Increase (Decrease)	(2,243.3)	2,309.9	513.0	579.6

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

There is no public access to and no opportunity for recreational activity on the federal lands, and the federal lands would remain inaccessible after completion of the Land Exchange Proposed Action. By comparison, the non-federal lands would be accessible to varying degrees, and therefore could host recreational activities, as defined by their respective ROS class. Tract 1 is the most accessible and therefore has the greatest potential for public recreational use. Tract 5 would likely be accessible from adjacent Superior National Forest land and/or the lake itself, while Tract 4 is also accessible via road and trail. Tracts 2 and 3 would be more difficult to access.

As Table 5.3.11-3 shows, the Land Exchange Proposed Action would result in a net decrease to the federal estate of 2,243.3 acres of land designated Semi-Primitive Motorized, an increase to the federal estate of 2,309.9 acres of land designated Semi-Primitive Non-Motorized, and an increase to the federal estate of 513.0 acres of Roaded Natural land. Although there would be a decrease of Semi-Primitive Motorized land to the federal estate, the Land Exchange Proposed Action overall would affect less than one-quarter of one percent of the total area of the Superior National Forest (approximately 3 million acres), and the reduction to the federal estate of this ROS type would be exceeded by the increase to the federal estate in other ROS types.

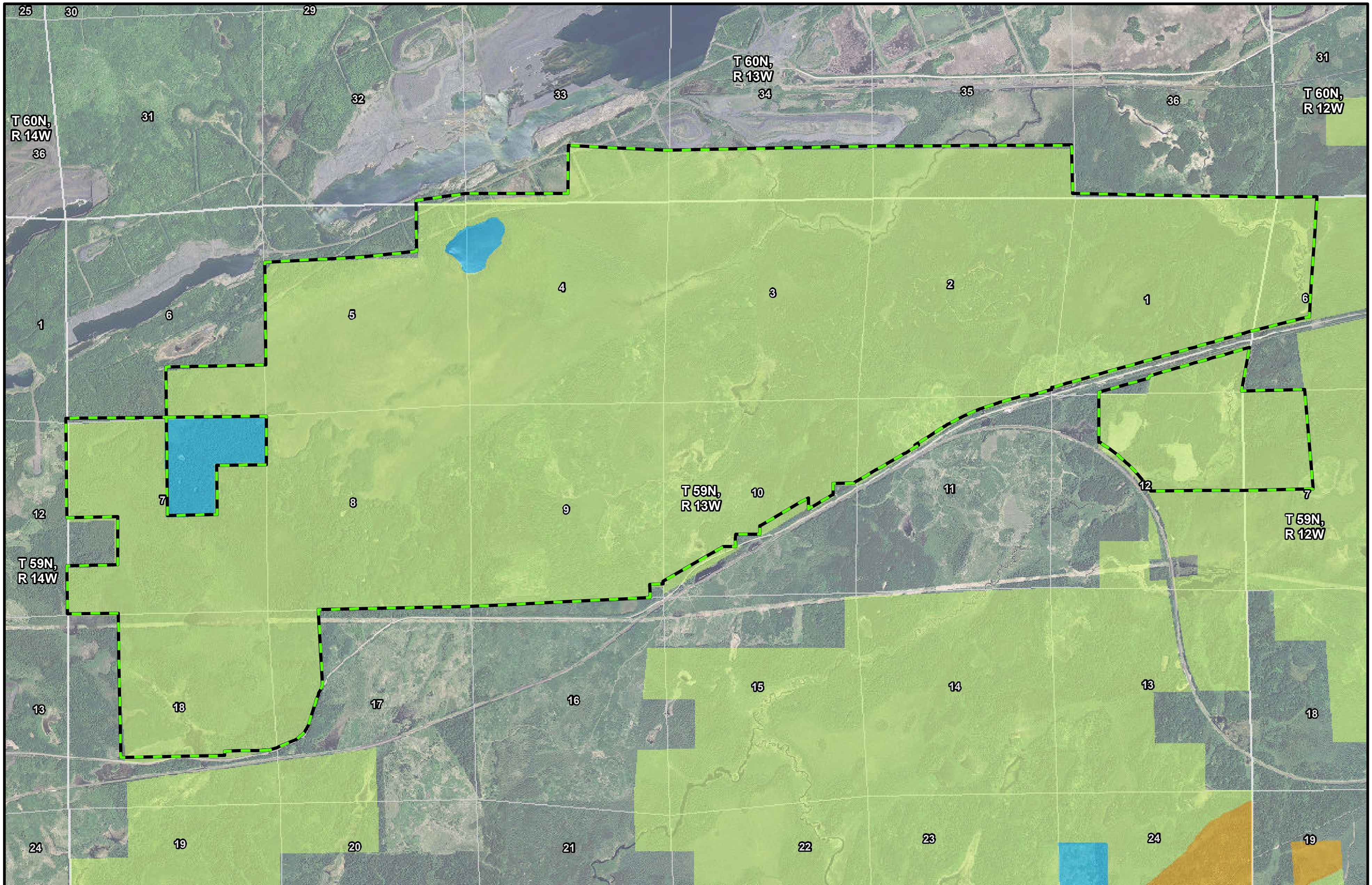
Because the federal lands are not accessible to the public, the Land Exchange Proposed Action represents an addition to the amount of potential publicly accessible land in the Superior National Forest. As a result, the Land Exchange Proposed Action would increase opportunities for hunting, fishing, and other recreational activities.

5.3.11.2.2 Visual Resources

SIOs for the federal lands are shown on Figure 5.3.11-4, while the SIOs that would be applied to the non-federal lands are shown in Figures 5.3.11-5 and 5.3.11-6. These are summarized in Table 5.3.11-4. The Low SIO of the federal lands indicates that the area is not intended to be a natural-looking landscape. Effects on visual resources on the federal lands are similar to those at the Mine Site, as discussed in Section 5.2.11.2.1.

The non-federal lands are only somewhat visible from public roads, few of which are elevated enough to afford views of the tracts themselves. Still, transfer of the non-federal lands to Superior National Forest ownership would generally help to preserve the scenic quality of those parcels. The NorthMet Project area would not be visible from any of the Land Exchange Proposed Action parcels.

The Land Exchange Proposed Action would result in a net decrease to the federal estate of 1,170.8 acres of land with a Low SIO and an increase to the federal estate of 136.3 acres of land with a High SIO and 1,644.6 acres of land with a Moderate SIO (Table 5.3.11-4). This change in the composition of the visual character of the Superior National Forest, which affects less than one-quarter of one percent of the total area of the forest, has generally positive aspects. The addition of land with Moderate and High SIO (in lieu of land with a Low SIO) could affect the types of forestry and management activities that can occur on those lands. The USFS would acquire land with a wider diversity of SIOs (i.e., the addition of land with Moderate and High SIOs) and the Land Exchange Proposed Action would result in a net increase to the federal estate.



Federal Lands
Section Boundary
Section Label

Scenic Integrity Objective

High
Moderate
Low
N/A

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US Army Corps of Engineers St. Paul District

Figure 5.3.11-4
Scenic Integrity Objective
Federal Lands
NorthMet Mining Project and Land Exchange PSDEIS
Minnesota

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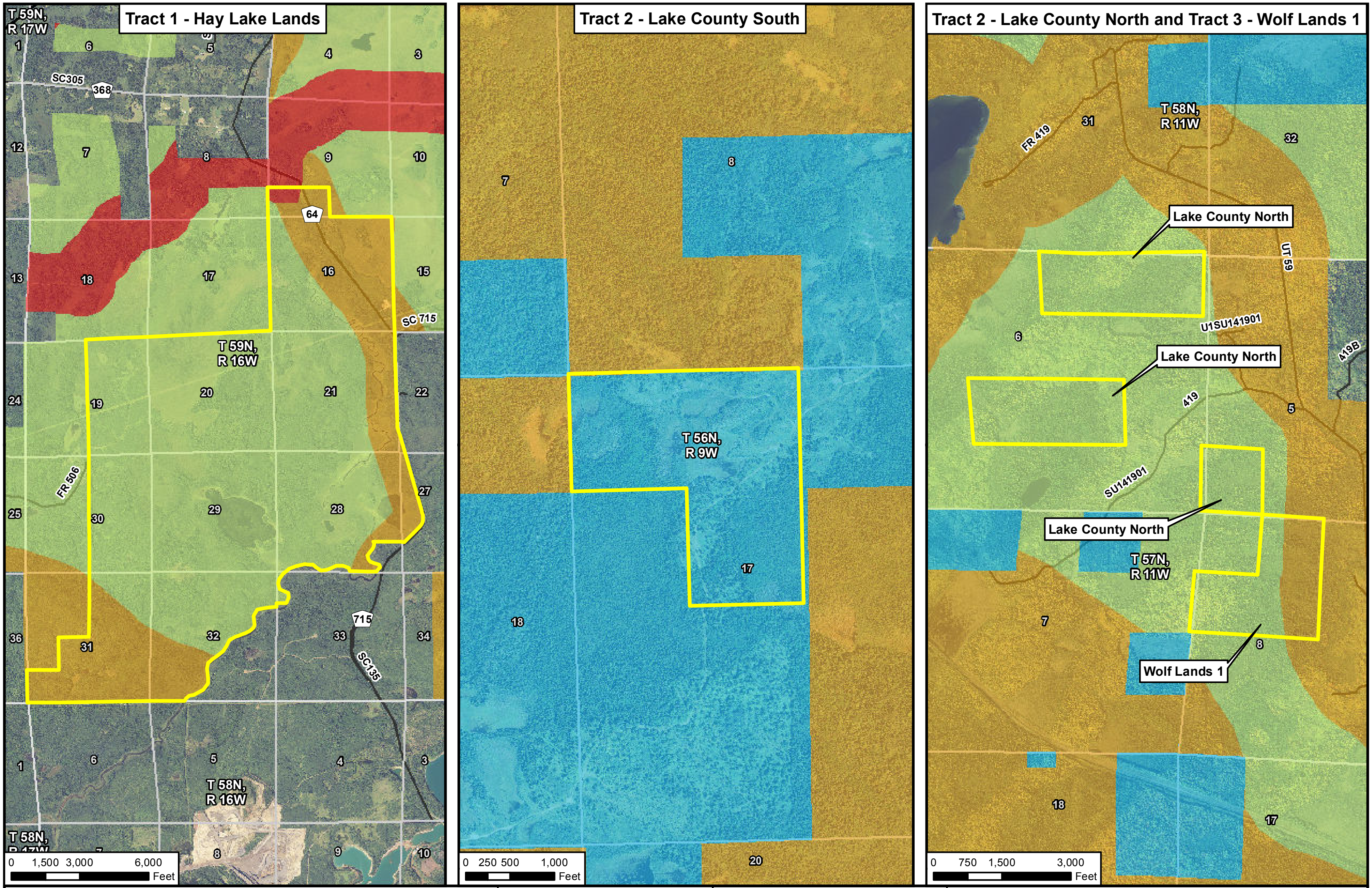

Non-federal Lands

Section Boundary

1 Section Label

Scenic Integrity Objective

- High
- Moderate
- Low
- N/A

Minnesota Department of Natural Resources

US Army Corps of Engineers St. Paul District

Forest Service U.S. Department of Agriculture

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N W E S

Figure 5.3.11-5

Scenic Integrity Objective

Tracts 1, 2 and 3

NorthMet Mining Project and Land Exchange PSDEIS

Minnesota

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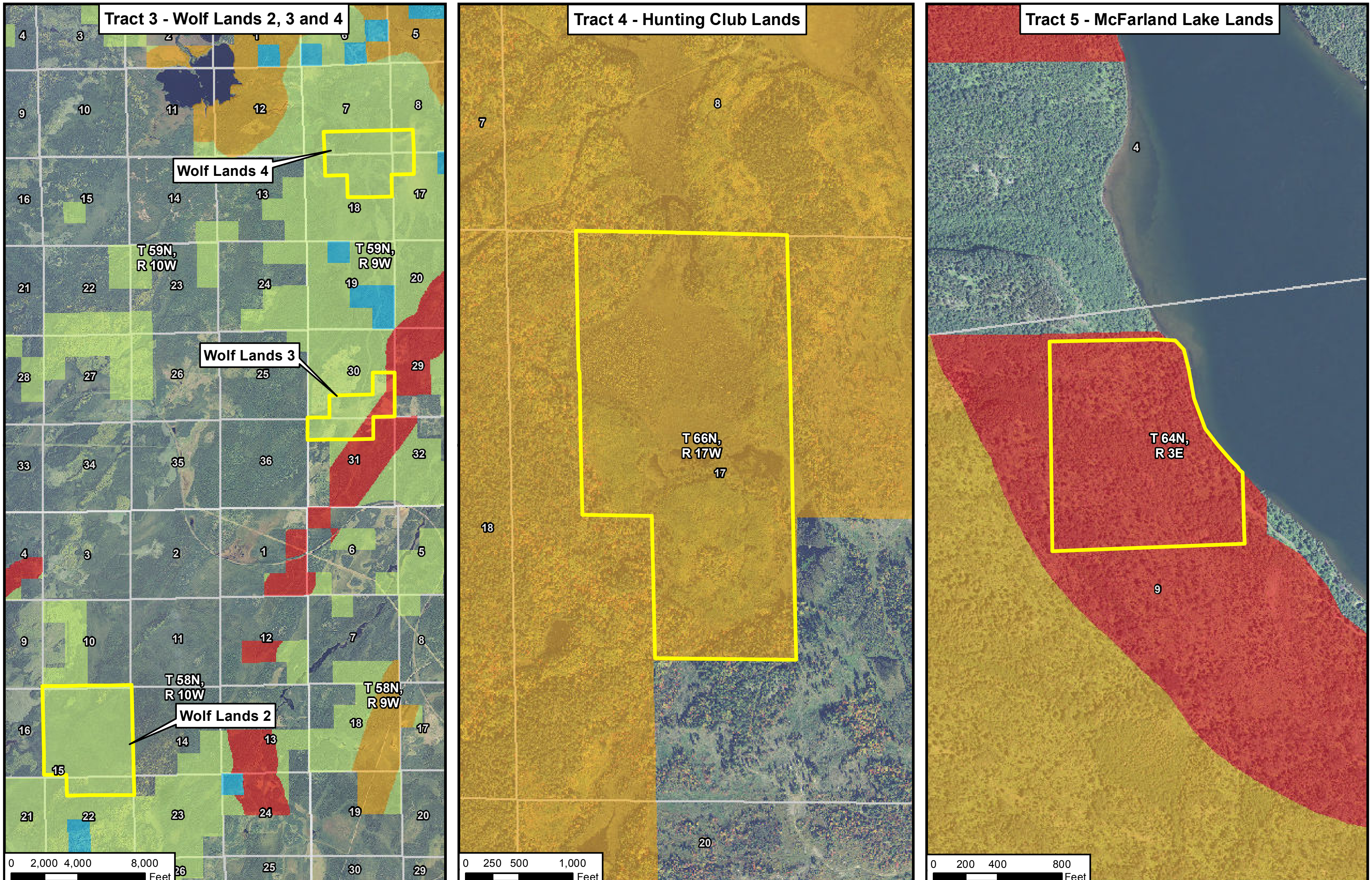

Non-federal Lands

Section Boundary

1 Section Label

Scenic Integrity Objective

- High
- Moderate
- Low
- N/A

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N W E S

Figure 5.3.11-6

Scenic Integrity Objective

Tracts 3, 4 and 5

NorthMet Mining Project and Land Exchange PSDEIS

Minnesota

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Table 5.3.11-4 Scenic Integrity Objectives of Federal and Non-Federal Lands (Proposed Action)

	Acres of Scenic Integrity Objective			
Parcel	**High**	**Moderate**	**Low**	**Total**
Lands Conveyed				
Federal lands	0.0	0.0	6,464.9[1]	6,463.6[1]
Lands Acquired				
Tract 1 - Hay Lake	20.4	1,315.4	3,590.5	4,926.3
Tract 2 - Lake County North	0.0	0.0	265.0	265.0
Tract 2 - Lake County South	0.0	116.9	0.0	116.9
Tract 3 - Wolf Land 1	0.0	52.1	73.7	125.8
Tract 3 - Wolf Land 2	0.0	0.0	767.9	767.9
Tract 3 - Wolf Land 3	85.1	0.0	192.3	277.4
Tract 3 - Wolf Land 4	0.0	0.0	404.7	404.7
Tract 4 - Hunting Club	0.0	160.2	0.0	160.2
Tract 5 – McFarland Lake	30.8	0.0	0.0	30.8
Subtotal: non-federal lands	136.3	1,644.6	5294.1	7,075.0
Net Change				
Net Increase (Decrease)	136.3	1,644.6	(1,170.8)	610.1

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

Notes:
1 Mud Lake (comprising 30.5 acres of the 6,495.4 acres in the federal lands) would not be managed by USFS, and therefore does not have a SIO.

5.3.11.3 Land Exchange No Action Alternative

5.3.11.3.1 Recreation

Under the Land Exchange No Action Alternative, the federal and non-federal lands would remain generally inaccessible to the public for recreation or other uses.

5.3.11.3.2 Visual Resources

Under the Land Exchange No Action Alternative, the visual appearance of the federal and non-federal lands would remain unchanged.

5.3.11.4 Land Exchange Alternative B

5.3.11.4.1 Recreation

Under the Land Exchange Alternative B, approximately 4,752.6 acres of federal lands would be exchanged for the 4,926.3-acre Tract 1. ROS classes for the federal lands portion of the Land Exchange Alternative B are shown on Figure 5.3.11-7 (Tract 1 classes would remain unchanged from the Land Exchange Proposed Action). Table 5.3.11-5 summarizes the ROS classes of these lands.

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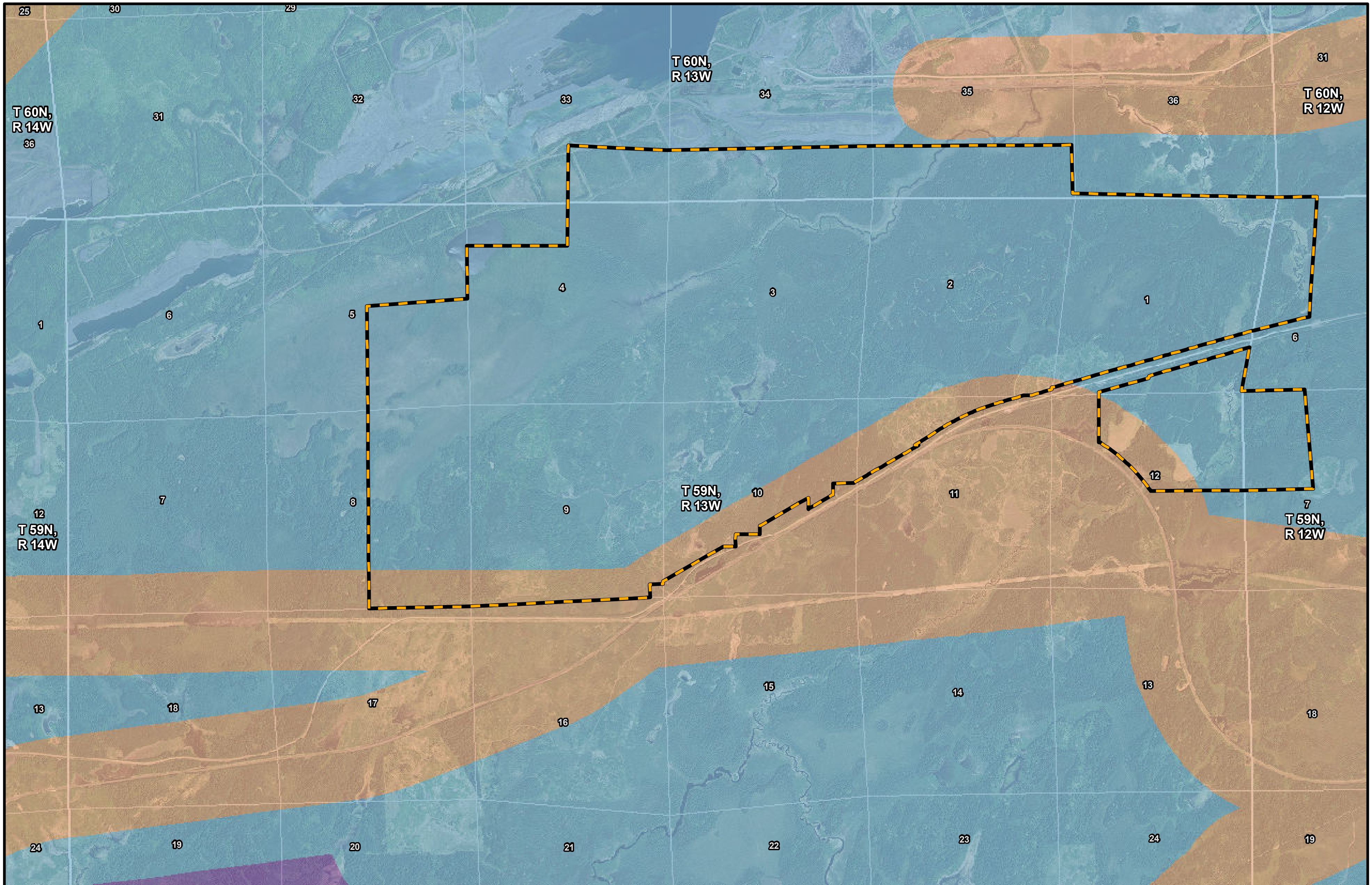

Alternative B: Smaller Federal Parcel

Section Boundary

Section Label

Recreation Opportunity Spectrum

Semi-Primitive Motorized

Semi-Primitive Non-motorized

Primitive

Roaded Natural

Rural

Urban

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Figure 5.3.11-7

Recreation Opportunity Spectrum

Alternative B: Smaller Federal Parcel

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Table 5.3.11-5 Recreation Opportunity Spectrum Class of Federal and Non-federal Lands (Land Exchange Alternative B)

	Acres of ROS Class			
Parcel	**Semi-Primitive Motorized**	**Semi-Primitive Non-Motorized**	**Roaded Natural**	**Total**
Lands Conveyed				
Federal lands	4,276.6	0.0	476.0	4,752.6
Lands Acquired				
Tract 1 - Hay Lake	1,303.8	2,162.2	1,460.3	4,926.3
Net Change				
Net Increase (Decrease)	(2,972.8)	2,162.2	984.3	173.7

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

Similar to the Land Exchange Proposed Action, there is no public access to and no opportunity for recreational activity on the federal lands, and the smaller federal parcel would remain inaccessible after completion of the Land Exchange Alternative B. By comparison, the non-federal lands (Tract 1) would be accessible (to varying degrees), and therefore would be capable of hosting recreational activities, as defined by their respective ROS classes. Tract 1 is accessible and therefore would result in the greatest potential for public recreational use.

As Table 5.3.11-5 shows, the Land Exchange Alternative B would result in a net decrease to the federal estate of 2,972.8 acres of land designated as Semi-Primitive Motorized, which would be offset by an increase to the federal estate of 2,162.2 acres of Semi-Primitive Non-Motorized land and 984.3 acres of Roaded Natural land. Although there would be a decrease of Semi-Primitive Motorized land, the Land Exchange Alternative B overall would affect less than one-quarter of one percent of the total area of the Superior National Forest, and the reduction to the federal estate of this ROS class would be exceeded by the increase to the federal estate in other ROS classes.

As with the Land Exchange Proposed Action, because the federal lands are not accessible to the public, the Land Exchange Alternative B represents an addition to the amount of potential publicly accessible land in the Superior National Forest. As a result, the Land Exchange Alternative B would increase opportunities for hunting, fishing, and other recreational activities. Overall, the effects of the Land Exchange Alternative B on recreation are similar to those of the Land Exchange Proposed Action, but smaller in magnitude, due to the reduced amount of land involved.

5.3.11.4.2 Visual Resources

SIO classifications for the smaller federal parcel are shown on Figure 5.3.11-8 (Tract 1 classifications would remain unchanged from the Land Exchange Proposed Action) and are summarized in Table 5.3.11-6. As with the Land Exchange Proposed Action, the Land Exchange Alternative B has a Low SIO, indicating the lands are not intended to be a natural-looking landscape; however, Tract 1 would only be somewhat visible from public roads and would generally help to preserve the scenic quality of the parcel. The NorthMet Project area would not be visible from Tract 1.

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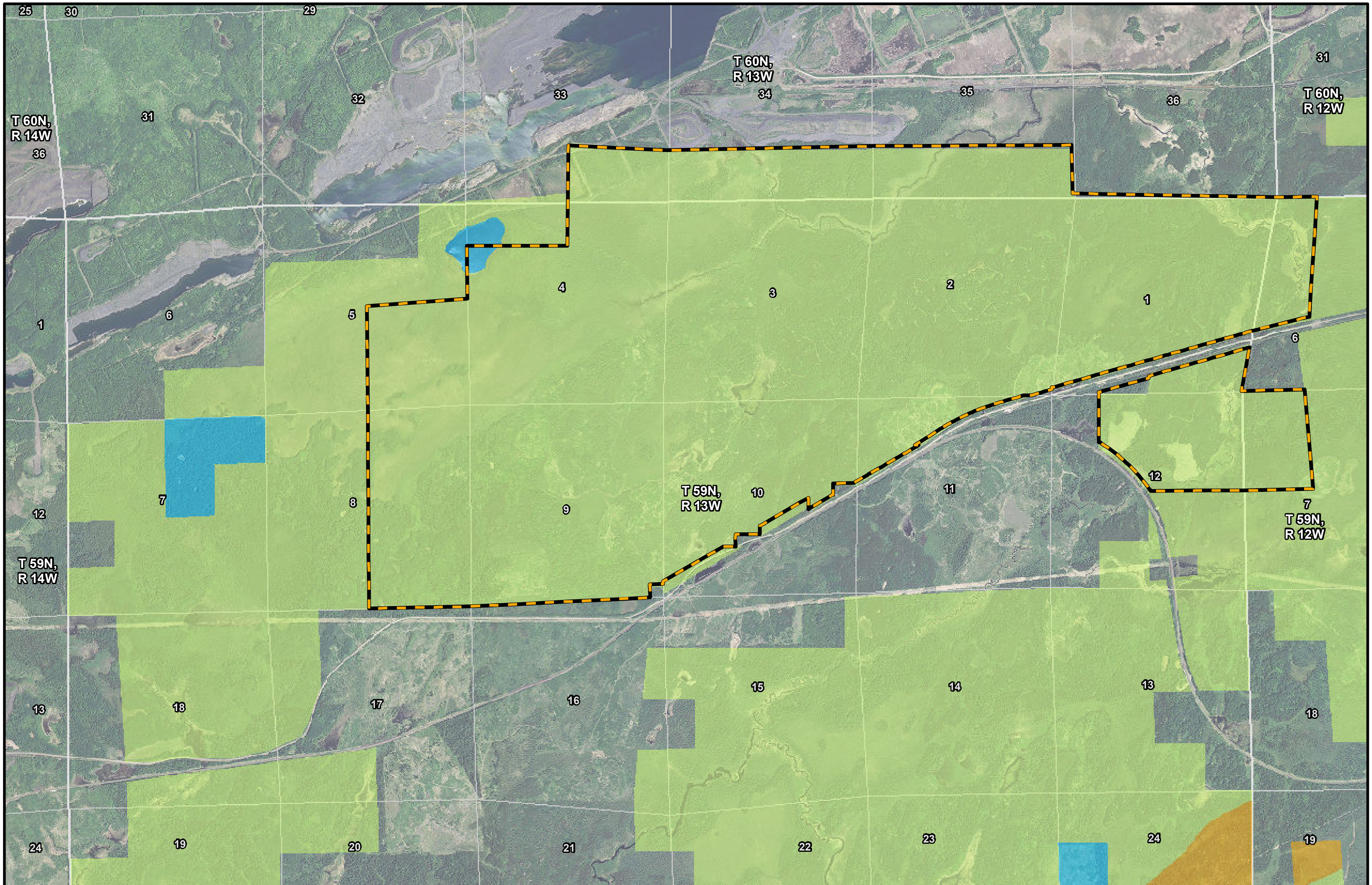

Alternative B: Smaller Federal Parcel

Section Boundary

1 Section Label

Scenic Integrity Objective

- High
- Moderate
- Low
- N/A

US Army Corps of Engineers St. Paul District

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Figure 5.3.11-8

Scenic Integrity Objective

Alternative B: Smaller Federal Parcel

NorthMet Mining Project and Land Exchange PSDEIS

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The Land Exchange Alternative B would result in a net decrease to the federal estate of 1,153.2 acres of land with a Low SIO, in exchange for an increase to the federal estate of 20.4 acres of land with a High SIO and 1,153.2 acres of land with a Moderate SIO. This change in the composition of the visual character of the Superior National Forest, which affects less than one-tenth of one percent of the total area of the Superior National Forest, has generally positive aspects. The addition of land with Moderate and High SIOs (in lieu of land with a Low SIO) could affect the types of forestry and management activities that can occur on those lands. The USFS would acquire land with a wider diversity of SIOs and the Land Exchange Alternative B would result in a net increase to the federal estate, although less than in the Land Exchange Proposed Action.

Table 5.3.11-6 Scenic Integrity Objectives of Federal and Non-federal Lands (Alternative B: Smaller Federal Parcel)

	Acres of Scenic Integrity Objective Classification			
Parcel	**High**	**Moderate**	**Low**	**Total**
Lands Conveyed				
Federal lands	0	0	4,743.7[1]	4,743.7[1]
Lands Acquired				
Tract 1 - Hay Lake	20.4	1,315.4	3,590.5	4,926.3
Net Change				
Net Increase (Decrease)	20.4	1,315.4	(1,153.2)	182.6

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

Notes:
[1] Mud Lake (comprising 8.9 acres of the 4,752.6 acres in the smaller federal parcel), would not be managed by USFS, and therefore does not have a SIO.

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5.3.12 Wilderness and Other Special Designation Areas

This section describes the potential environmental consequences of the Land Exchange Proposed Action on wilderness and other special designation area resources that are on or near the federal and non-federal lands.

The Land Exchange Proposed Action would not result in a net increase or decrease in any wilderness areas. However, the Land Exchange Proposed Action would result in a net increase of 306.9 acres of cRNAs to the federal estate. Land Exchange Alternative B would result in the same net changes as the Land Exchange Proposed Action.

The Land Exchange No Action Alternative would not affect wilderness or special-designation areas as the Land Exchange would not occur.

5.3.12.1 Methodology and Evaluation Criteria

An evaluation was conducted to determine the potential effect that the Land Exchange Proposed Action would have on the wilderness character of the area. Potential effects on noise, water resources, and recreation and visual resources were evaluated. The analysis of the wilderness character affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies.

Estimated ambient noise levels at each of the sensitive receptor sites adjacent to the federal lands were compared with modeled noise levels to determine effects. An appropriate noise propagation model was used to generate noise contours from the Mine Site and Plant Site. To determine effects on water resources, in addition to available information from field efforts already performed by PolyMet for the NorthMet Project Proposed Action, analysis of air photos and available GIS layers for federal and non-federal lands included data layers and other collected data such as National Wetland Inventory maps, soil maps/ecological land type maps, and FEMA floodplain maps. Scenic quality and integrity of lands being acquired and conveyed was determined based on desktop study and limited field observations where necessary. The Forest Plan uses a nationally recognized classification system, the ROS, to describe different recreation settings, opportunities, and experiences. Reviewing existing information and consultation with area land managers provided the information needed to understand the existing and potential recreation opportunities.

5.3.12.2 Land Exchange Proposed Action

The Land Exchange Proposed Action would result in a net increase of cRNAs to the federal estate. As indicated in Section 5.3.1, the USFS has determined that Tract 1 would have the following management area designations: General Forest and cRNA. Therefore, the Land Exchange Proposed Action would include the Pike Mountain and Loka Lake cRNAs (southwest corner and northeast corner of the tract, respectively). The addition of Tract 1 into the federally managed areas would extend the Pike Mountain cRNA by 135.7 acres of primarily hardwoods plant community, and would extend the Loka Lake cRNA by 171.2 acres of lowland black spruce and tamarack swamp. The remaining 4,619.3 acres would be allocated to General Forest.

Tracts 2, 3, 4, and 5 would not result in a net change to wilderness or other special designation areas.

5.3.12.3 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing the wilderness and other special designations on or near the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS's responsibility for managing these resources and would result in no further effects on existing wilderness areas or other special designated areas.

5.3.12.4 Land Exchange Alternative B

The Land Exchange Alternative B would result in the same net increase of cRNAs to the federal estate as the Land Exchange Proposed Action. The Land Exchange Alternative B would not result in a net change to any wilderness area.

5.3.13 Hazardous Materials

The Land Exchange Proposed Action would not include operations or activities that involve the use of hazardous materials on federal or non-federal lands beyond those activities specific to the NorthMet Project Proposed Action described in Section 5.2.13. AOCs associated with legacy contamination by hazardous materials from former activities and operations on these lands are discussed in Section 5.3.1.

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5.3.14 Geotechnical Stability

Geotechnical stability considerations for the proposed stockpiles that would be located on federal land subject to the Land Exchange Proposed Action within the NorthMet Project area are discussed in Section 5.2.14. There are no other existing or proposed large-scale waste material storage facilities on land subject to the Land Exchange Proposed Action.

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