SCOPING ENVIRONMENTAL ASSESSMENT WORKSHEET
DATA SUBMITTAL

TWIN METALS MINNESOTA PROJECT
Environmental Review Support Document

Prepared for Twin Metals Minnesota LLC
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REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Use	N/A	1.0
1A	07-24-2020	Updated to reflect MDNR and MPCA Comments	N/A	1.0
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REVISION NARRATIVE

Revision 1A provides updates to the SEAW data submittal as a result of review and comment by the Minnesota Department of Natural Resources and Minnesota Pollution Control Agency.

Revision 2A provides updates to reflect MDNR and MPCA Comments Received 12.1.20.

Revision 3A provides updates to the SEAW data submittal in response to comments received from MDNR 12.1.20 that required additional conversation with MDNR and MPCA. The topic areas that have been addressed in this revision are water nomenclature, rock nomenclature, project infrastructure, wetlands, and water modeling.

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

<	less than
>	greater than
°	degree
%	percent
AADT	annual average daily traffic
amsl	above mean sea level
ARD	acid rock drainage
ARDC	Arrowhead Regional Development Commission
Barr	Barr Engineering Co.
bgs	below ground surface
BMP	Best Management Practice
BMZ	basal mineralized zone
BWCAW	Boundary Waters Canoe Area Wilderness
CAA	Clean Air Act
cm	centimeter
cm/sec	centimeters per second
CO	carbon monoxide
CR	county road
dBA	A-weighted decibels
e.g.	Latin phrase exempli gratia meaning “for example”
EAW	environmental assessment worksheet
ECS	Ecological Classification System
EIS	Environmental Impact Statement
ELT	Ecological Land Type
EOR	Emmons & Oliver Resources, Inc.
EPM	environmental protection measure
EQB	Environmental Quality Board
ERA	Environmentally relevant areas

etc.	abbreviation for the Latin phrase et cetera meaning "and other similar things" or "and so forth"
FAM	Forest Agricultural Management District
Foth	Foth Infrastructure & Environment, LLC
FR	Forest and Recreation
ft	feet
gal	gallon
GAP	Gap Analysis Project
GHG	greenhouse gas
GIS	geographic information system
GPS	global positioning system
GRB	Giants Range Batholith
GWMAP	Ground Water Monitoring and Assessment Program
ha	hectares
HAP	hazardous air pollutants
HDPE	high density polyethylene
HGU	hydrogeologic units
HUC	Hydrological Unit Code
i.e.	Latin phrase id est meaning “That is (to say)…”
IBI	Index of Biotic Integrity
INCO	International Nickel Company, Ltd
IND	Industrial
IPaC	Information for Planning and Consultation
ISO	International Organization for Standardization
Km	kilometers
LHD	load-haul-dump machines
LiDAR	light detection and ranging
LLDPE	linear low-density polyethylene
LLR	longitudinal longhole retreat
LMF	Laurentian Mixed Forest
LOS	level of service
m	meter
m^3	cubic meter
MBS	Minnesota Biological Survey
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
mg/L	milligrams per liter
mil	thousandth of an inch
Minn. R.	Minnesota Administrative Rules
ML	metal leaching
mm	millimeter
MM	Mineral Mining District
MMR	Minimum Maintenance Road
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
mph	miles per hour
MPO	Mine Plan of Operations

MWI	Minnesota Well Index
NAAQS	National Ambient Air Quality Standards
NAC	noise area classifications
NFR	National Forest Road
NHIS	Natural Heritage Information System
NLCD	National Land Cover Database
NO_2	nitrogen dioxide
NPC	Native Plant Community
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSU	Northern Superior Uplands
NWI	National Wetlands Inventory
OHV	off-highway vehicle
OSA	Office of the State Archaeologist
POI	points of interest
PR	potential cultural resources
Project	Twin Metals Minnesota Project
PSD	prevention of significant deterioration
PVC	polyvinyl chloride
Q	quarter
QUM	quaternary unconsolidated materials
RCRA	Resource Conservation and Recovery Act
RES	Residential
RFSS	Regional Forester Sensitive Species
RGU	responsible governmental unit
RR	Residential Recreation
SAG	semi-autogenous grind
SEAW	Scoping Environmental Assessment Worksheet
SEH	Short Elliott Hendrickson Inc.
SGCN	Species in Greatest Conservation Need
SHPO	State Historic Preservation Office
SKA	South Kawishiwi Association
SKI	South Kawishiwi Intrusion
SNF	Superior National Forest
SO_2	sulfur dioxide
SWPPP	Stormwater Pollution Prevention Plan
TDS	total dissolved solids
TH	Trunk Highway
TMDL	total maximum daily load
TMM	Twin Metals Minnesota LLC
tpd	tons per day
tpy	tons per year
TSS	total suspended solids
µg/L	microgram per liter
$µg/m^3$	microgram per cubic meter
µS/cm	microSiemens per centimeter
U.S.	United States
USACE	U.S. Army Corps of Engineers

USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCA	Minnesota Wetland Conservation Act
yd^3	cubic yards

GLOSSARY

This glossary is intended to help the reader understand how Twin Metals Minnesota is using terms within this document. These are not intended to be legal definitions, nor are they intended to encompass or resolve the comprehensive and differing definitions and interpretations that can be found in federal, state, and local law and rule.

1854 Treaty Authority: An inter-tribal natural resource management agency that manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of the Lake Superior Chippewa in the territory ceded under the Treaty of 1854.

access road: The primary road critical to TMM operations used to transport concentrate to market, transport reagents and consumables, and provide access to employees; the access road would be from the north of the plant site off Trunk Highway 1.

access road corridor: The standardized name for the corridor from Trunk Highway 1 to the plant site; this corridor would contain the access road for the project.

archaeological site: The physical remains of any area of human activity, generally greater than 50 years of age, for which a boundary can be established. Examples of such resources could include domestic / habitation sites, industrial sites, earthworks, mounds, quarries, canals, roads, etc. Under the general definition, a broad range of site types would qualify as archaeological sites without the identification of any artifacts.

acid rock drainage: A low pH, metal-laden, sulfate-rich drainage that occurs during land disturbance where sulfur or metal sulfides are exposed to atmospheric conditions. It forms under natural conditions from the oxidation of sulfide minerals and where the acidity exceeds the alkalinity. Non-mining exposures, such as along highway road cuts, may produce similar drainage. Also known as **acid mine drainage (AMD)** when it originates from mining areas.

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

ambient air quality: The quality of the portion of the atmosphere, external to buildings, to which the public has general access.

aquatic biota: Collective term describing the organisms living in or depending on the aquatic environment.

aquifer: A subsurface saturated formation of sufficient permeability to transmit groundwater and yield usable quantities of water to wells and springs.

attainment area: A geographic area considered to have air quality as good as or better than the National Ambient Air Quality Standards as defined in the Clean Air Act.

average: A measure of the statistical mean of the data set.

backfill plant: At the backfill plant, tailings filter cake would be repulped and blended with binder to create an engineered tailings backfill.

bedrock: The rock of the earth's crust that is below the soil and largely un-weathered.

berm: A mound or wall of earth.

best available control technology: An emissions limitation based on the maximum degree of control that can be achieved. It is a case-by-case decision that considers energy, environmental, and economic impacts. This can be add-on control equipment or modification of existing production processes or methods. It includes fuel cleaning or treatment and innovative fuel combustion techniques. This may be a design, equipment, work practice, or operational standard if imposition of an emissions standard is infeasible.

best management practice: The schedule of activities, prohibition of practices, maintenance procedures, and other management practices to avoid or minimize pollution or habitat destruction to the environment. Best management practices can also include treatment requirements, operating procedures and practices to control runoff, spillage, or leaks; sludge or waste disposal; or drainage from raw material storage.

Boundary Waters Canoe Area Wilderness: This wilderness is a unique area located in the northern third of the Superior National Forest in northeastern Minnesota. It is approximately 1.3 million acres in size, extends nearly 150 miles along the International Boundary adjacent to Canada's Quetico Provincial Park, and is bordered on the west by Voyageurs National Park. The Boundary Waters Canoe Area Wilderness contains over 1,200 miles of canoe routes, 11 hiking trails, and approximately 2,000 designated campsites.

Class I Area: Under the Clean Air Act, this is an area in which visibility is protected more stringently than under the National Ambient Air Quality Standards, with only a small increase in pollution permitted. Such areas typically include national parks, wilderness areas, monuments, and other areas of special national and cultural significance.

Class II Area: Under the Clean Air Act, this designation applies to all clean air regions *not* designated Class I areas, with moderate pollution increases allowed.

Clean Air Act: This Act defines the U.S. Environmental Protection Agency's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer. The last major change in the law, the Clean Air Act Amendments of 1990, was enacted by Congress in 1990. This Act was incorporated into the United States Code as Title 42, Chapter 85.

Clean Water Act: This act is the primary federal law in the United States governing water pollution. The act establishes the goals of eliminating releases of high amounts of toxic substances into water, eliminating water pollution, and ensuring that surface waters meet standards necessary for human sports and recreation. This act does not directly address groundwater contamination. Groundwater protection provisions are included in the Safe Drinking Water Act, Resource Conservation and Recovery Act, and the Superfund Act.

closure: The process of terminating and completing final steps in reclaiming any specific portion of a mining operation. Closure begins when, as prescribed in the Permit to Mine, there would be no renewed use or activity by the permittee and is defined in Minnesota R., part 6132.0100, subpart 6.

comminution circuit: Process circuit to reduce the particle size of ore.

comprehensive land use plan: A document adopted by local elected officials that establishes policies and guidance for land use, municipal growth, public services, and infrastructure. Comprehensive plans can provide the rationale and legislative basis for local zoning and subdivision ordinances.

concentrate: Concentrates would be the end products of the TMM Project. These concentrates would contain the minerals that would be separated from rock in the mine. TMM's concentrates would be produced either through the flotation process or the gravity concentration process and would be sold on a global market.

concentrate dewatering: Process circuit consisting of thickening and filtration to produce a concentrate filter cake that is ready for shipment.

concentrate storage and loadout: Temporary concentrate storage area at the concentrator before that would include a loadout area to load trucks with concentrate for shipment.

concentrator: A subset of the process related to recovery of the target metals. The concentrator would include grinding, gravity concentration, flotation, concentrate dewatering, concentrate storage and loadout, and reagent makeup. The concentrator would be located at the plant site.

concentrator services building: The building that would contain surface maintenance, warehouse, change rooms for concentrator and tailings dewatering plant operators, and offices.

construction dewatering water: Surface water and groundwater removed to dry and/or solidify a construction site to enable construction activity.

construction stormwater: Direct precipitation, precipitation runoff, stormwater runoff, snowmelt runoff, and surface runoff and drainage that has contacted surfaces disturbed by construction activities that could have increased constituent loading.

construction rock: A subcategory of waste rock that could be used as construction material. This rock would have primary objectives and selection criteria that will be determined by the ongoing Mine Materials Characterization Program.

consultation (for cultural resources): The process of seeking, discussing, and considering the views of other participants, and, where feasible, seeking agreement with them regarding matters arising in the Section 106 process. The Secretary's "Standards and Guidelines for federal Agency Preservation Programs pursuant to the National Historic Preservation Act" provide further guidance on consultation.

contact water: Water that comes in direct contact with ore or waste rock (except construction rock) or infiltrates into tailings.

contamination: The intrusion of undesirable (i.e., unwanted physical, chemical, biological, or radiological) elements, or matter that has a negative effect on air, water, or land.

copper concentrate: The first flotation product that would recover copper, gold, silver, platinum, and palladium while minimizing the amount of nickel and cobalt recovered.

corehole: A hole drilled in bedrock to retrieve a core sample.

criteria air pollutant: Seven common air pollutants for which the US Environmental Protection Agency has set primary (may harm human health) or secondary (may affect the environment and/or cause property damage) national air quality standards. These pollutants are particulate matter less than or equal to 10 microns in size, particulate matter less than or equal to 2.5 microns in size, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead.

cultural resources: Archaeological, traditional, and built environment resources, including but not necessarily limited to buildings, structures, objects, districts, and sites.

cumulative effect: The effects on the environment that would result from the incremental effect of a proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

dBA: A-weighted decibel.

decibel: A unit expressing the relative intensity of sounds on a logarithmic scale from zero (for the average least perceptible sound) to approximately 130 (for the average level at which sound is perceived as painful to humans).

decline conveyor: The conveyor that would transport ore from the underground crushing stations up the decline to the transfer tower on the surface.

dike: A structure that directs the flow of water.

draindown: Draindown is any draining of entrained process water that would mix with infiltrating precipitation and be collected by the dry stack facility liner system. Draindown is categorized as mixed water.

dry stack facility: A dry stack facility is the most sustainable method used to store filtered tailings cake produced from the processing after the 4% of the ore that is copper, nickel, cobalt, platinum, palladium, gold, and silver is recovered. Before placement at the dry stack facility, the tailings would be filtered, and the majority of water is removed. The dry stack facility would be a lined facility where the tailings filter cake (silty sandy material) is placed and compacted in lifts. The dry stack facility is constructed in three stages (stage 1, stage 2, and stage 3), generally from west to east.

dry stack facility perimeter ditch: A ditch around the dry stack facility that collects water from the over-liner drain and under-liner drain for conveyance to tailings management site pond 1. This ditch's catchment area begins at the downslope edge of the dry stack facility runoff collection ditch and extends to the perimeter haul road. Water in this ditch is categorized as mixed water.

dry stack facility runoff collection ditch: Ditches around the dry stack facility that collect runoff and direct it to ponds at the tailings management site. Water in these ditches is categorized and managed as either industrial stormwater or non-contact water depending on the reclamation status of contributing areas.

ecological land type: A hierarchical level of the National Hierarchical Framework of Ecological Units and Ecological Classification System that is determined based on differences in vegetation, soils, climate, geology, and/or hydrology.

eligible (for historic properties): Historic properties formally determined as such in accordance with the regulations of the Secretary of the Interior and all other properties that meet the National Register criteria.

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

Endangered Species Act: This act was enacted in 1973 (16 United States Code Section 1531 et seq.) and was designed to protect critically imperiled species from extinction as a "consequence of economic growth and development un-tempered by adequate concern and conservation." This act is administered by the U. S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration.

engineered tailings backfill: Tailings which would be combined with a binder and pumped underground as a thickened slurry for placement in mined out stopes. The binder would increase the structural integrity, minimize movement of water, and enhance the chemical stabilization of the engineered tailings backfill.

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

environmental protection measures: Measures TMM would take to avoid, minimize, and/or mitigate potential effects.

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

extreme storm event: unexpected, severe, or unseasonal weather events, specifically weather events at the extremes of historical distribution.

filter cake storage and loadout building: The filter cake storage and loadout building would be located adjacent to the filter building. It would temporarily store tailings filter cake until it is loaded onto trucks and transported to the dry stack facility for placement.

filter plant: The facility that would produce tailings filter cake for placement on the dry stack facility or for use in backfill.

flotation circuit: Process circuit to recover the target metals into two flotation concentrates, a copper concentrate and a nickel concentrate. The waste product from this process is tailings.

footwall: The mass of rock underlying a mineral deposit or the bedrock located beneath a fault plane.

fragmentation: A decrease in the area of contiguous habitat available to wildlife.

fugitive dust: Airborne particulate matter. This can include emissions from haul roads, wind erosion, exposed surfaces, and other activities that remove and redistribute soil.

gangue mineral: Commercially worthless minerals that are closely mixed with valuable minerals in an ore deposit.

GAP land cover: A hierarchically organized vegetation cover map developed as part of the U.S. Geological Survey's Gap Analysis Program. Units of analysis are Minnesota Ecological Classification System subsections.

Giants Range Batholith: A 2.68-billion-year-old granitoid batholith composed of silica-poor rocks ranging from diorite to quartz monzonite in composition.

glacial drift: Generic and inclusive term for any material that has been transported by glacial ice.

glacial till: Glacial deposits that are unsorted and unstratified.

gravity concentrate: The product of the gravity concentration circuit that would target the recovery of platinum, palladium, and gold.

gravity concentration circuit: Process circuit within the comminution circuit used to recover targeted metals, including platinum, palladium, and gold to produce gravity concentrate. The gravity concentration circuit uses the differences in the density of the gold, platinum, and palladium minerals to separate these denser minerals from the remaining minerals.

greenhouse gas: Gases that trap heat in the atmosphere. Some greenhouse gases, such as carbon dioxide, occur naturally and are emitted to the atmosphere through natural processes and human activities. The principal greenhouse gases that enter the atmosphere because of human activities are carbon dioxide, methane, nitrous oxide, and fluorinated gases.

groundwater: The water located beneath the ground surface in soil or rock pore spaces or fractures.

groundwater cutoff wall: The seepage cutoff trench with grout curtain as necessary depending on bedrock conditions surrounding the dry stack facility.

haul road: A specific subset of service road that would surround the dry stack facility and be used by haul trucks to transport tailings filter cake onto the dry stack facility.

hazardous air pollutant: Air pollutants that are not covered by ambient air quality standards, but that may present a threat of adverse human health or environmental effects. These pollutants are listed on the federal list of 189 hazardous air pollutants in 40 Code of Federal Regulations 61.01.

hazardous material: Any item or agent (biological, chemical, physical) that has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. The term includes hazardous substances, hazardous waste, marine pollutants, and elevated-temperature materials—materials designated as hazardous under the provisions of 49 CFR 172.101. Hazardous material categories include explosives, gases, flammable liquids, flammable solids, spontaneous combustibles/dangerous when wet, oxidizers and organic peroxides, poisons and infectious substances, and corrosives.

hazardous waste: A category of waste regulated under the Resource Conservation and Recovery Act. Such waste includes solid waste listed in the Resource Conservation and Recovery Act that exhibits at least one of four characteristics (as described in 40 Code of Federal Regulations 261.20 through 261. 24): ignitability, corrosivity, reactivity, or toxicity; or that is listed by the U.S. Environmental Protection Agency in 40 Code of Federal Regulations 261.31 through 261.33.

hydrology: The study of water characteristics, especially the movement of water; or the study of water (including aspects of geology, oceanography, and meteorology).

hydraulic conductivity: A measure of the ease with which a medium transmits water, such as water moving through pore spaces or fractures in soil or rock.

industrial stormwater: Direct precipitation, precipitation runoff, stormwater runoff, snowmelt runoff, and surface runoff and drainage that has contacted industrial areas or activities that could have increased constituent loading and is not process water, contact water, or mixed water. This would include stormwater and snowmelt runoff from the surface of dry stack facility tailings assuming such water is in compliance with applicable standards.

impaired water: As defined under Section 303(d) of the Clean Water Act, waters that are too polluted or degraded to meet the water quality standards set by states, territories, or authorized tribes.

in situ: This refers to actions happening “in place” or “in position” where they would naturally occur.

invasive species: Organisms that cause, or are likely to cause, harm to the economy, environment, or human health due to their tendency to out-compete other species.

Laurentian Divide: A geological formation that runs along the crest of low, rocky hills and divides the Red River and Rainy River basins from the Minnesota River and Lake Superior basins. The Laurentian Divide is part of the Northern Divide, a continental divide that separates drainages to the Hudson Bay and Arctic Ocean from all other drainages in North America. Streams on the north slope of the divide flow through Canada to Hudson Bay. On the south side of the divide, streams flow south to either Lake Superior and the Atlantic Ocean, or the Mississippi River and the Gulf of Mexico.

L_{10}: Sound levels not to be exceeded 10 percent of the time.

L_{50}: Sound levels not to be exceeded 50 percent of the time.

laydown area: Area used for material and equipment storage throughout the Project.

leachate: A product solution obtained by leaching, in which a substance is dissolved by the action of a percolating liquid.

Light Detection and Ranging: An optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser. Light Detection and Ranging is often used to create surface elevation models and contour datasets.

mine inflow: Groundwater that flows into the mine.

mine services building: The building that would contain the truck shop, mine dry, and warehouse.

mine supply water: Water that would be pumped underground and used for dust suppression and equipment requirements like drill water.

Minnesota Environmental Policy Act: The purposes of Minnesota Law 1973, Chapter 412, are: (a) to declare a state policy that will encourage productive and enjoyable harmony between human beings and their environment; (b) to promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of human beings; and (c) to enrich the understanding of the ecological systems and natural resources important to the state and to the nation.

Minnesota Routine Assessment Method: A method used to evaluate wetland functions. It is a practical assessment tool that is used to help local authorities make sound wetland management decisions using descriptive rather than numeric ratings.

mixed water: A mixture of process water and one or more other types of water. Managed as either process water or contact water, depending on its properties.

modeling: Predicting the probability of an outcome given a set amount of input data.

National Ambient Air Quality Standards: The Clean Air Act requires the U.S. Environmental Protection Agency to set these standards (40 Code of Federal Regulations Part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of these standards. *Primary standards* provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

National Environmental Policy Act: This act (42 United States Code 4321 et seq.) was signed into law on January 1, 1970. The act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within federal agencies. The National Environmental Policy Act requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

National Historic Preservation Act: This act (Public Law 89-665; 16 United States Code 470 et seq.) is legislation intended to preserve historical and archaeological sites in the United States of America. The act created the National Register of Historic Places, the list of National Historic Landmarks, and the State Historic Preservation Offices. It was signed into law on October 15, 1966. The act requires federal agencies to evaluate the impact of all federally funded or permitted projects on historic properties (i.e., buildings, archaeological sites, etc.) through a process known as Section 106 review.

National Register of Historic Places: The official list of the Nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.

National Wetland Inventory: The U.S. Fish and Wildlife Service (Service) is the principal federal agency that provides information to the public on the extent and status of the Nation's wetlands. The Service has developed a series of topical maps to show wetlands and deep water habitats. This geospatial information is used by federal, state, and local agencies, academic institutions, and private industry for management, research, policy development, education, and planning activities related to wetlands.

nickel concentrate: The second flotation product that would recover nickel, cobalt, the remaining copper, platinum, palladium, gold, silver, and the remaining sulfides.

noise: Sound that interferes with speech and hearing and that is undesirable.

noise-sensitive receptors: Locations or areas where dwelling units or other fixed, developed sites of frequent human use occur.

non-contact water: Direct precipitation, stormwater, and surface water that has not contacted ore, waste rock, tailings, industrial areas, or activities, or surfaces disturbed by construction activities, including runoff from reclaimed surfaces and water from adjacent watersheds diverted around the facility.

non-contact water ditch: A ditch that would be constructed within the non-contact water diversion area to divert non-contact water around project features at the plant site and tailings management site.

non-contact water diversion area: A system of ditches and dikes that would be used to direct non-contact water away from the plant site and tailings management site.

non-contact water pond: A location where non-contact water would pond in the non-contact water diversion area after a diversion dike was installed to prevent surface water from flowing into the plant site or the tailings management site.

off-site electrical substation: The electrical substation west of Dunka pit.

ore: Rock mined that contains the targeted metals – copper, nickel, cobalt, platinum, palladium, gold, and silver – which would be recovered through the concentrator to produce three concentrates.

overburden: Waste material and/or rock covering a mineral deposit, or unconsolidated material covering bedrock.

secondary ore stockpile: The secondary ore stockpile would be utilized when the primary ore stockpile is at capacity; this condition would occur intermittently during operations. Ore on the secondary ore stockpile would be rehandled and transferred to the primary ore stockpile on a priority basis as capacity within the facility allowed.

over-liner drain: A drain internal to the dry stack facility that would be installed above the liner that drains to the dry stack facility perimeter ditch.

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

permeability: A measure of the ability of a material (such as soil or rock) to transmit fluids.

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

piezometer: A device that measures the pressure or level of groundwater at a specific point.

plant site: The portion of the Project area that would encompass the following Project features: plant site pond 1, plant site pond 2, plant site pond 3, process water pond, concentrator, temporary rock storage facility, primary ore stockpile, secondary ore stockpile, concentrator services building, mine services building, and the plant site electrical substation.

plant site electrical substation: The electrical substation at the plant site.

$PM_{2.5}$: Fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

PM_{10}: Inhalable particles, with diameters that are generally 10 micrometers and smaller.

prevention of significant deterioration: Applies to new major sources or major modifications at existing sources for pollutants where the area the source is located is in attainment or unclassifiable with the National Ambient Air Quality Standards. It requires the use of Best Available Control Technology, air quality analysis, additional impacts analysis, and public involvement to protect public health and welfare; preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value; ensure that economic growth would occur in a manner consistent with the preservation of existing clean air resources; and assure that any decision to permit increased air pollution is made only after careful evaluation of all the consequences of such a decision and after adequate procedural opportunities for informed public participation in the decision making process.

Primary ore stockpile: Covered ore stockpile that is the primary feed stockpile for the concentrator during the operations phase of the project.

process: The process terminology is used to discuss the process as a whole and is inclusive of the concentrator and tailings dewatering plant.

process water: Water used in the concentrator to process the ore.

process water pond: Centrally located pond west of the concentrator that would be used to store process water.

Project: The Twin Metals Minnesota Project. The Project would consist of the underground mine, the plant site, the tailings management site, the non-contact water diversion area, the access road, the water intake corridor, and the transmission corridor.

Project area: An area that includes the proposed footprints of Project features and sufficient adjacent area to capture the surface environment potentially affected by Project ground disturbance.

proposed action: Proposal to authorize and implement an action that addresses a purpose and need.

proposed project: A proposed action, the results of which would cause physical manipulation of the environment, directly or indirectly.

reagent makeup: Process circuit dedicated to preparing reagents for use in the process.

reclamation: Activities that successfully accomplish the requirements of Minnesota Rules, parts 6132.2000 to 6132.3200.

reclamation stockpile: stockpile of material suitable as a growth medium such as topsoil and peat for reclamation. Material would be stripped and stored during clearing and construction of the Project.

Resource Conservation and Recovery Act: This gives the U.S. Environmental Protection Agency the authority to control hazardous waste from “cradle-to-grave.” This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. This also sets forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to the Resource Conservation and Recovery Act enabled the Environmental Protection Agency to address environmental problems that could result from underground storage tanks storing petroleum and other hazardous substances. These amendments also address storage and disposal of solid and hazardous wastes.

riparian: Area pertaining to the bank of a river, stream, pond, or small lake.

Recreation Opportunity Spectrum: The framework expressing the desired range of recreational activities that will be encouraged and permitted on national forest lands.

seepage: Water that may flow through a liner, independent of pathway.

sediment pond: A pond used for settling suspended solids.

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

slurry: A watery mixture or suspension of fine solids.

State Historic Preservation Office: The office and official appointed or designated pursuant to section 101(b)(1) of the National Historic Preservation Act to administer the State Historic Preservation Program or a representative designated to act for the State Historic Preservation Officer.

stormwater: According to Minnesota Rules, chapter 7090, stormwater is defined as stormwater runoff, snow melt runoff, and surface runoff and drainage.

study area: An area of evaluation specific to a particular resource, different from a Project area.

suitable growth medium: A combination of topsoil, peat, and mineral soil.

tailings: Tailings are the leftover finely ground (milled) ore after the desired minerals have been physically separated and removed.

tailings dewatering plant: Would include the process facilities associated with the tailings thickener, filter plant, filter cake storage and storage loadout building, and backfill plant.

tailings filter cake: The tailings product resulting after pressure filtration; the tailings filter cake would have a majority of water removed by the filter.

tailings management site: The tailings dewatering plant, the dry stack facility and related materials management infrastructure.

tailings thickener: The equipment that would be used to initially dewater tailings before being fed to the filter plant to produce a tailings filter cake.

temporary: lasting for only a limited period of time or a fixed duration and not permanent. If a potential impact would be reversed as a part of the Project, it has the characteristic of being temporary.

temporary rock storage facility: Physical infrastructure on which ore and waste rock that does not meet the selection criteria for construction rock would be stockpiled during the construction phase of the project. It is a lined facility at the plant site that would convey precipitation to plant site pond 2.

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

till: A glacial drift consisting of an unsorted mixture of clay, sand, gravel, and boulders.

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

transmission corridor: The transmission corridor would be a corridor beginning at the off-site electrical substation located west of the Dunka River, extending northeast, and terminating at the plant site electrical substation. The transmission corridor would include a two-track, unpaved maintenance road and the power transmission line.

unconsolidated deposit: Sediment not cemented together; may consist of sand, silt, clay, and organic material.

under-liner drain: A drain underneath the dry stack facility liner that would drain to the dry stack facility perimeter ditch.

underground mine: This includes the underground workings as well as ventilation raise sites, ventilation raise site access roads, underground mobile equipment, and underground mine infrastructure.

underground mine area: The surface projection of the underground workings and underground Maturi deposit.

underground mine water: Water collected by the dewatering system including mine inflow (groundwater that flows into the underground mine), process water associated with the engineered tailings backfill; and mine supply water. Underground mine water is categorized as mixed water.

underground workings: This includes all underground excavations (i.e., ramps, haulage areas, drifts, stopes, and ventilation raises) beginning at the point the decline or raise goes below ground surface.

U.S. Forest Service Regional Forester Sensitive Species: A list developed by the Regional Forester that identifies sensitive species. Sensitive species are defined as “plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by: (a) significant current or predicted downward trends in population numbers or density, and/or (b) significant current or predicted downward trends in habitat capability that would reduce a species’ existing distribution.” Sensitive species are usually designated for an entire region, but independent “Forest Sensitive” lists are maintained by some individual National Forests.

U.S. Geological Survey gaging station: Facilities used by hydrologists to automatically monitor streams, wells, lakes, canals, reservoirs, and or other water bodies. Instruments at these stations collect information such as water height, discharge, water chemistry, and water temperature.

ventilation access road: An existing drill road would be upgraded in order to access ventilation raise site 1 and 2. Ventilation raise site 3 would be accessed via the existing USFS road, National Forest Road 1900. A portion of National Forest Road 1900 would also be used to access the upgraded drill road.

ventilation raise site 1, 2, and 3: The ventilation raise sites serve as air intake and exhaust locations for the underground mine and are labelled from west to east.

waste rock: Rock that may or may not contain metallic mineralization but is not profitable to process for the purposes of producing concentrate.

water intake corridor: The standardized name for the corridor from the water intake facility on Birch Lake to the plant site; this corridor would contain the pipeline for the makeup water, buried electric, and a single lane access road.

water intake facility: The make-up water pumphouse for withdrawal from Birch Lake.

watershed: A geographic area from which water is drained by a river and its tributaries to a common outlet. A ridge or drainage divide separates a watershed from adjacent watersheds.

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

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

Wetland Conservation Act: This act was passed into law in 1991 (and the rules were promulgated in 1993 and amended in 1993, 1994, 1996, 2000, and 2009), with the purpose of achieving no net loss in the quantity, quality, and biological diversity of Minnesota’s existing wetlands; increasing the quantity, quality, and biological diversity of Minnesota’s wetlands by restoring or enhancing diminished or drained wetlands; avoiding direct or indirect impacts from activities that destroy or diminish the quantity, quality, and biological diversity of wetlands; and replacing wetland values where avoidance of activities is not feasible and prudent.

wetland delineation: The act of establishing the boundary between wetlands and uplands (or non-wetlands) using soils, hydrology, and vegetation as indicators.

wild rice: A tall aquatic annual grass of North America, bearing edible grain that typically grows in shallow lakes or slow-moving rivers and streams.

zoning ordinance: Locally adopted regulations that divide a town, city, village, or county into separate districts (e.g., residential, commercial, or industrial), define the permitted and prohibited land uses in those districts, and set forth specific development requirements (such as minimum lot size, height restrictions, etc.

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of Ely, Minnesota, and 11 miles (18 km) northeast of Babbitt, Minnesota (Figure 1-1), the Project targets valuable and strategic state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which would dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review of the Project.

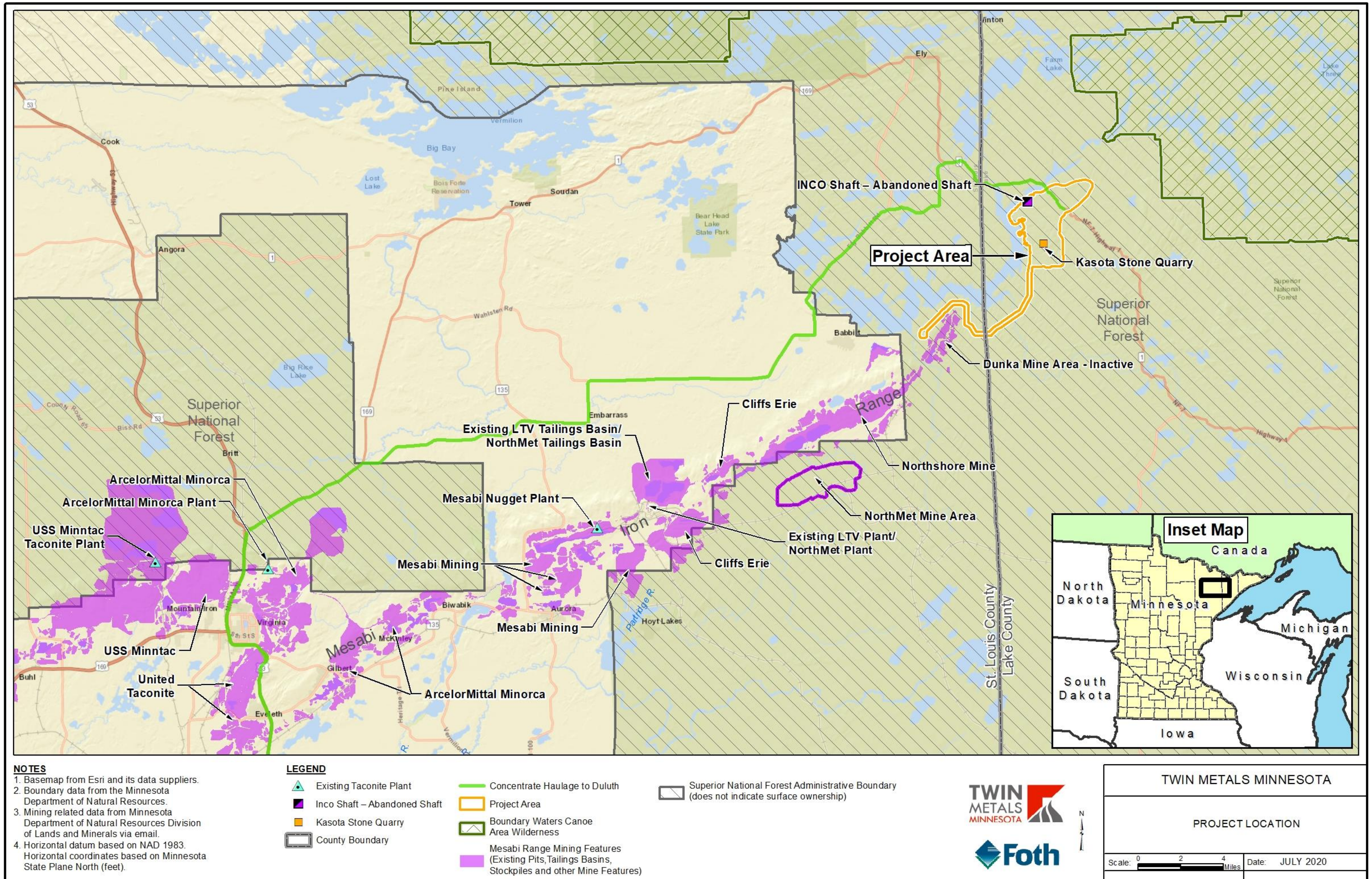


Figure 1-1 Project Location

2.0 APPROACH

TMM has prepared this document as a data submittal to facilitate the state environmental review process and to help refine the scope of the future Environmental Impact Statement (EIS) and to identify potentially significant environmental impacts.

As a metallic mineral mine, the Project will require completion of an EIS, with the Minnesota Department of Natural Resources (MDNR) as the responsible governmental unit (RGU) for conducting the environmental review (Minnesota Statutes, section 116D.04 and Minn. R., chapter 4410). For projects that require an EIS, an environmental assessment worksheet (EAW) is used as a tool for determining the scope of the EIS. This tool is referred to as a scoping EAW (SEAW), as it is paired with a scoping decision document that outlines what alternatives, impacts, issues, and mitigation measures will be assessed in the EIS, and at what level of detail.

This SEAW data submittal provides state agencies and the public a detailed Project description based on current design and engineering evaluations, a summary of baseline environmental conditions, an assessment of potential effects from the Project, and a description of future work necessary to support an EIS. The goal for this document is to inform discussions with state agencies leading to concurrence on the potential for significant environmental effects, outstanding data needs, and the recommended scope of the EIS. TMM as the proposer, acknowledges that the decisions about the content and format for the final published SEAW remain the sole responsibility of the lead state agency.

This SEAW data submittal follows the EAW format prescribed by the Minnesota Environmental Quality Board (EQB), and includes the following sections:

- Project Description
- Cover Types
- Permits and Approvals
- Land Use
- Geology, Soils Topography/Land Forms
- Water Resources
- Contamination / Hazardous Materials / Wastes
- Terrestrial and Aquatic Resources
- Historic Properties and Cultural Resources
- Visual
- Air
- Noise
- Transportation
- Cumulative Potential Effects
- Other Potential Environmental Effects
- RGU Certification

The project description in this SEAW data submittal is based on current design and engineering evaluations which TMM believes are adequate to scope analyses for the EIS. Portions of the project description are expected to be updated in the Draft and Final EIS. These updated project descriptions are expected to reflect the purpose of those documents, additional detailed design, additional analysis, and the further development of the project. Additional details that will likely be utilized in updated project descriptions may include but are not limited to:

- details on process water flow, including water appropriations;
- details on water definitions;
- details on water management;
- details on chemical balances;
- design or construction details of water management features, including ponds, dikes, and ditches;
- operating details of water management features, including ponds, dikes, and ditches;
- design or construction details on the dry stack facility;
- operating details of the dry stack facility;
- design or construction details of liners and cover systems; and
- details on reclamation and closure.

In each section addressing resources (Sections 4.0 to 15.0), this document describes baseline conditions and potential Project impacts, as required by the EAW form. This document also goes beyond the EAW form requirements, and for each resource type, addresses future scope of work. The subsections on future scope assess whether additional data or analysis is needed, and if it is, describe the recommended scope of work.

This SEAW data submittal uses information from a number of sources, some of which is publicly available with other information being data acquired by TMM that is summarized to supplement the assessment. Beyond what is presented in the data submittal, additional work and data collection is ongoing and reflected in the sections on Future Scope.

Sections on baseline conditions describe the current environment within the Project area. The Project area includes the underground mine, plant site, tailings management site, non-contact water diversion area, access road, water intake corridor, and transmission corridor, as shown on Figure 2-1. These sites and areas represent discrete geographical portions of the Project named for the most prominent facility in that area, but each area or site contains a variety of facilities that may be subject to different federal and state regulatory programs. The Project area encompasses the proposed footprints Project features and sufficient adjacent area to capture the surface environment potentially affected by Project ground disturbance.

Sections on Project impacts describe potential effects of Project construction, operation, reclamation, and closure, as well as measures TMM would take to avoid, minimize, and/or mitigate potential effects (environmental protection measures [EPM]).

The analysis of Project impacts concludes with an assessment of whether the available information is 1) adequate to make a reasoned decision about the potential for, and significance of, the Project environmental impacts; 2) is insufficient but could be reasonably obtained; or 3) is insufficient but unlikely able to be reasonably obtained.

For the resources for which available information is adequate to make a reasoned decision about the potential for, and significance of, the Project environmental impacts, the section concludes with an evaluation of the potential significance of the impacts. The factors used to evaluate whether a potential effect would be considered significant are specified by Minn. R., part 4410.1700, subparts 6 and 7 as:

- The type (temporary or permanent), extent and reversibility of the potential effect;
- Does the potential effect contribute to a cumulative potential effect (identify what and how);
- Is the potential effect subject to regulatory oversight and mitigation (identify the regulatory control); and
- The extent to which environmental effects can be anticipated and controlled as a result of other available environmental studies.

For the resources for which available information is insufficient but could be reasonably obtained, the section concludes with a preliminary evaluation of the potential significance of the impacts.

Sections on the future scope of work identify specific studies or data collection that would be conducted to obtain additional data identified as lacking but able to be reasonably obtained. The assessment of potential cumulative effects are not included within the future scope of work sections. They are included in Section 14.0. The future scope sections identify the following:

- Specific questions that need to be answered by the additional study;
- Which permits (if any) the scope of work would inform;
- The approach for the study;
- The study boundary under consideration; and
- The specific deliverables.

Upon conclusion of the proposed future scopes of work, information collected will be combined with information presented in this document to assess potential impacts to the identified resources. The sufficiency of the data will be assessed, and the significance of the potential impacts will be evaluated using the factors specified by Minn. R., part 4410.1700, subparts 6 and 7 (listed above). Note all references to federal and state statutes and regulations reference those in effect as of the date of filing.

Overall, this document provides agencies with an assessment of the potential Project environmental effects and their significance, an evaluation of information adequacy, an EIS scoping recommendation, and future scopes of work for the EIS.

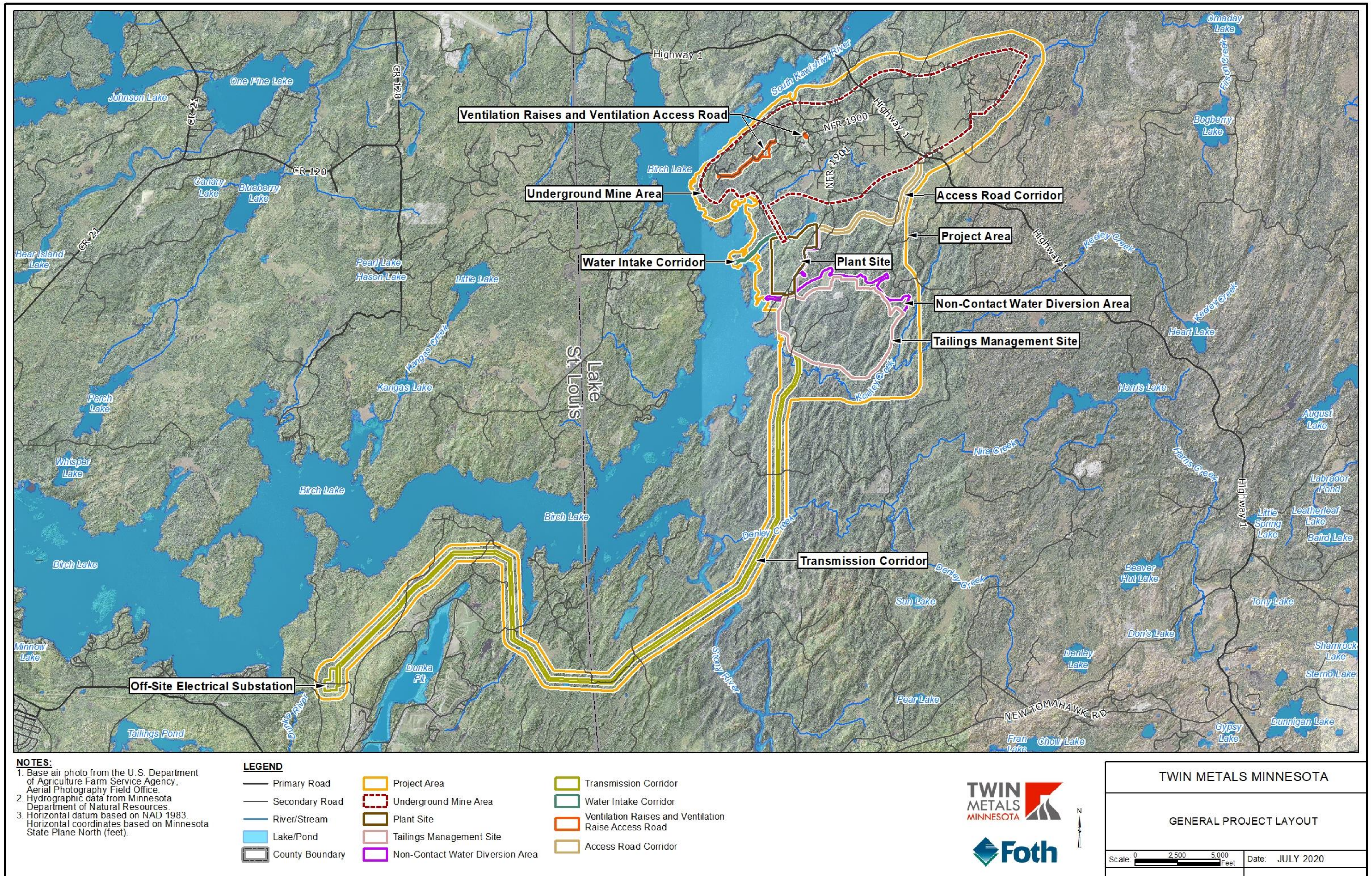


Figure 2-1 General Project Layout

3.0 BACKGROUND

3.1 Project Title

Twin Metals Minnesota Project

3.2 Proposer

Twin Metals Minnesota LLC
Contact person:
Title:
Address:
Phone:
Fax:
Email:

3.3 RGU

Minnesota Department of Natural Resources
Contact person:
Title:
Address:
Phone:
Fax:
Email:

3.4 Reason for SEAW Preparation

Required:
☒ EIS Scoping
☐ Mandatory EAW

Discretionary:
☐ Citizen petition
☐ RGU discretion
☐ Proposer initiated

If EAW or EIS is mandatory, give EQB rule category subpart number(s) and name(s):

Minn. R., part 4410.4400 Subpart 8b. Subpart Name: Metallic mineral mining and processing metallic minerals.

3.5 Project Location

- County: Lake and St. Louis
- City / Township: Stony River Township and Babbitt
- PLS Location (¼, ¼, Section, Township, Range):
- Township 60N, Range 11W, Section 6
- Township 60N, Range 12W, Section 1, 3
- Township 61N, Range 11W, Sections 3, 4, 5, 6, 8, 9, 10, 15, 16, 17, 20, 29, 31, 32
- Township 61N, Range 12W, Sections 25, 26, 34, 35, 36
- Township 62N, Range 11W, Sections 32, 33, 34, 35

- Watershed (81 major watershed scale): Rainy River – Headwaters (72)
- Tax Parcel Number: See Table A1 of Appendix A

Plant site and underground mine area:

- County: Lake
- City / Township: Stony River Township
- Plant site - Township 61N, Range 11W, Sections 8, 9, 10
- Underground mine area- Township 61N, Range 11W, Sections 3, 4, 5, 6, Township 62N, Range 11W, Sections 32, 33, 34, 35
- Watershed: Rainy River – Headwaters (72)
- Centroid of plant site and underground mine area Coordinates (UTM Zone 15) X: 594530 Y: 5294615

Tailings management site:

- County: Lake
- City / Township: Stony River Township
- Township 61N, Range 11W, Sections 15, 16
- Watershed: Rainy River – Headwaters (72)
- Centroid of tailings management site (UTM Zone 15) X: 59440 Y: 5291475

Transmission corridor:

- County: Lake and St. Louis
- City / Township: Stony River Township and Babbitt
- Township 60N, Range 11W, Section 6
- Township 60N, Range 12W, Section 1, 3
- Township 61N, Range 11W, Sections 17, 20, 29, 31, 32
- Township 61N, Range 12W, Sections 25, 26, 34, 35, 36
- Watershed: Rainy River – Headwaters (72)
- Centroid of transmission corridor (UTM Zone 15) X: 590820 Y: 5285695

3.6 Project Description

3.6.1 Project Summary

The Project would be an underground mine and concentrator for copper, nickel, cobalt, platinum, palladium, gold, and silver ore from the Maturi deposit of the Duluth Complex. The Project would be located southeast of Ely and northeast of Babbitt.

3.6.2 Complete Description

The Project would be located at the northeastern end of Minnesota's Iron Range, southeast of Ely, and northeast of Babbitt, as shown on Figure 1-1.

The Project would recover copper, nickel, cobalt, platinum, palladium, gold, and silver, from the Maturi deposit. The Project would consist of an underground mine, a plant site, a tailings management site, and a non-contact water diversion area along with an access road, water intake corridor, and transmission corridor as shown on Figure 2-1. The surface disturbance of each of these Project features are summarized in Table 3-1. TMM would pursue the appropriate land approvals necessary to facilitate the Project.

Table 3-1 Project Magnitude Surface Disturbance

Project Feature	Acres
Total Project	1156
Plant Site	153
Tailings Management Site	653
Transmission Corridor	187
Access Road	44
Water intake corridor	8
Ventilation raise sites and access road	15
Non-contact Water Diversion Area	97

The mine would be accessed by portals and declines with mining occurring underground. The surface projection of the underground workings and Maturi deposit, referred to as the underground mine area, would have minimal surface disturbance limited to three ventilation raise sites and an associated ventilation access road. Mined ore would be crushed underground, then conveyed to the surface and processed in a comminution and flotation circuit at the plant site. The process would produce three products, copper concentrate, nickel concentrate, and gravity concentrate. The concentrates would be thickened and filtered before being transported off site to various customers. Tailings from the concentrator would be dewatered and either permanently stored underground as engineered tailings backfill or transported to the dry stack facility at the tailings management site for permanent storage. A simplified schematic of the mining process is shown on Figure 3-1.

3.6.2.1 Operating Life of Mine, Amount, Sequence, and Schedule

TMM estimates total production of approximately 180 million tons (163 million tonnes) of ore over 25 years, at an average rate of approximately 7.3 million tons (6.6 million tonnes) per year after Project ramp-up. Annually, the Project would produce on average 174,000 tons (157,000 tonnes) of copper concentrate, 84,000 tons (76,000 tonnes) of nickel concentrate, and 550 tons (500 tonnes) of gravity concentrate.

The Project would have four phases.

- The construction phase would occur during a 30-month period from Q3 Year -3 to Q4 Year -1 (note that in the Project schedule quarters refers to a 3 month unit of time and not to a specific calendar quarter). This phase would include final engineering, procurement, and construction of surface facilities and underground infrastructure. The timeline for construction is shown on Figure 3-2;

- The operation phase would begin with the commissioning of the concentrator and last for 25 years. This phase would include extracting and processing the ore, as well as activities such as water and waste management. Concurrent reclamation would occur during the operations phase and portions of the mine would be closed during this time (e.g., backfilled stopes);
- The reclamation and closure phase would occur after the operation phase. Final reclamation and closure would include monitoring and rehabilitation of areas with ground disturbance related to the Project and creation of the post-Project landscape; and
- The post-closure maintenance and monitoring phase would follow the reclamation and closure phase. This phase would include activities to confirm that reclamation has been sustained and that post-closure performance criteria have been achieved. The end of this phase would be marked by completing all applicable maintenance and monitoring requirements set forth in federal or state surface authorizations, mineral leases, permits, and applicable land management plans after which TMM would submit a request for release from applicable authorizations, such as the Permit to Mine.

3.6.2.2 Overview of Rock Management

TMM would manage mined rock based on three rock categories:

- Ore: rock mined that contains the targeted metals – copper, nickel, cobalt, platinum, palladium, gold, and silver – which would be recovered through the concentrator to produce three concentrates;
- Waste rock: rock that may or may not contain metallic mineralization but is not profitable to process for the purposes of producing concentrates;
- Construction rock: a subcategory of waste rock that would be used for construction material.

The material characterization program would further define the rock types and their suitable uses. Primary objectives and selection criteria for construction material will be determined as part of the ongoing Mine Materials Characterization Program. Section 5.1.3 discusses the current status of TMM's material characterization program summarizing key findings and Section 5.3 presents a future work scope for the continued development and execution of the material characterization program.

During the construction phase of the project, there would be three categories of rock: ore, waste rock and construction rock (a subcategory of waste rock). All rock brought to surface during the construction phase would either qualify as construction rock or would be placed in the temporary rock storage facility to be processed through the concentrator. The temporary rock storage facility is a lined facility designed with ditching to direct flow of runoff to plant site pond 2 where it is collected as contact water and stored until use in the processing circuit during commissioning and operations. The collected contact water in plant site pond 2 may be used underground as necessary (e.g. drilling water). The ore in the temporary rock storage facility would be processed when the concentrator begins operating and all material in the temporary rock storage facility would be withdrawn within the first two years of concentrator operations.

During the operation phase, ore would be crushed underground and transported by conveyor to the primary ore stockpile. Waste rock mined during operations would be managed underground by placing the waste rock in mined out stopes prior to backfilling with engineered tailings backfill. As required and as determined by selection criteria developed as part of the Mine Material Characterization Program, some of the waste rock may be utilized as construction rock.

Preliminary analysis suggests that through the design of the Project and the rock management strategy, the potential for acid rock drainage (ARD) from the two most common ARD sources associated with mines of this type (ARD from waste rock stockpiles and ARD from tailings) has been avoided. First, the Project would not have waste rock stockpiles on surface, due to the underground mining and processing strategy of ore, thus avoiding the potential for ARD from waste rock stockpiles on surface. Second, the Project would recover most sulfides from the ore, producing tailings with sulfur less than 0.2% S. This value of sulfur in tailings is significant because testwork on Duluth Complex tailings, including tailings from the Project's pilot plant on Maturi ore, has demonstrated that sulfur concentration at this level to be non-acid generating (testwork results are summarized in Section 5.1.3). Metal leaching (ML) potential of the tailings is currently being analyzed through kinetic testing as summarized in Section 5.1.3.

3.6.2.3 Overview of Water Management and Water Balance

TMM would manage water to avoid and minimize environmental impacts subject to appropriate federal and state agency oversight. TMM anticipates that the specific permitting requirements will be developed as additional data collection, modeling, and analysis is completed during the environmental review and permitting process. Accordingly, the details of its water management approach may evolve in response to agency review or additional technical review. Overall, water would be routed from the underground mine to the plant site, from the plant site to the tailings management site, then from the tailings management site back to the plant site. Birch Lake would supply make-up water for processing, as needed.

Key principles of the Project water management approach are as follows:

- The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water;
- Extensive water reuse would minimize the amount of make-up water needed from Birch Lake; and
- Stormwater and surface water from outside the site would be diverted, following natural drainage patterns to the extent possible, so it does not mix with water on the site. This water would be classified as non-contact water and would not be used as a source of process water.

Water would be managed in seven categories:

- Process water – water used in the concentrator to process the ore;
- Mixed water – a mixture of process water and one or more other types of water. Managed as either process water or contact water, depending on its properties;
- Contact water – water that comes in contact with ore or waste rock (except construction rock) or infiltrates into tailings;
- Industrial stormwater – direct precipitation, precipitation runoff, stormwater runoff, snowmelt runoff, and surface runoff and drainage that has contacted industrial areas or activities that could have increased constituent loading and is not process water, contact water, or mixed water. This would include stormwater and snowmelt runoff from the surface of dry stack facility tailings assuming such water is in compliance with applicable standards;
- Non-contact water – direct precipitation, stormwater, and surface water that has not contacted ore, waste rock, tailings, industrial areas, or activities, or surfaces disturbed by construction activities, including runoff from reclaimed surfaces and water from adjacent watersheds diverted around the facility;
- Construction stormwater – direct precipitation, precipitation runoff, stormwater runoff, snowmelt runoff, and surface runoff and drainage that has contacted surfaces disturbed by construction activities that could have increased constituent loading; and
- Construction dewatering water – surface water and groundwater removed to dry and/or solidify a construction site to enable construction activity.

The water use strategy would set the following priority order for process water sources:

1. Reuse of process water;
2. Use of mine inflow;
3. Use of contact water;
4. Use of industrial stormwater; and
5. Make-up water from Birch Lake.

A simplified schematic of the Project water management strategy is shown in Figure 3-3.

Water balance analysis indicates that the Project would be a net-consumer of water. Even with extensive water reuse, the Project would require make-up water to process the ore. The Project would have the following consumptive uses:

- Residual water would remain in the filtered tailings placed on the dry stack facility;
- Water would be consumed in the engineered tailings backfill;
- Residual water would remain in the filtered concentrates that are shipped to market; and
- Evaporation would occur from multiple sources across the Project.

The Project would capture water from the following sources and use it to meet process water demand:

- Mine inflow – the groundwater that would flow into the underground workings; and
- Precipitation – direct precipitation and stormwater that would be collected as contact water and industrial stormwater.

Water from mine inflow and precipitation would be variable and water that could not be used immediately in the process would be stored in ponds across the site to meet future water demand.

The Project's combined consumptive use would be greater than the combined water sources of mine inflow and precipitation. Therefore, to meet processing water demand the Project would intermittently withdraw make-up water from Birch Lake. Water from Birch Lake would be withdrawn on an as-needed basis when the process water demand could not be met by available mine inflow, contact water, and industrial stormwater in storage. The average withdrawal from Birch Lake would be expected to fall within the range of 75 to 130 million gallons (gal) of water a year. To achieve the required withdrawal, the instantaneous rate of pumping would be approximately 800 gallons per minute and would be stopped when other sources of water meet water demands. To put the withdrawal into context, 800 gallons per minute is equivalent to approximately 50 to 80 garden hoses.

Details on water management and the water balance are provided in the section *Water Management Plan*.

3.6.2.4 Underground Mine

The underground mine would consist of all underground workings and infrastructure necessary to excavate ore from the Maturi deposit over the 25-year operating phase including the ventilation raises that surface at the three ventilation raise sites. The underground mine would be accessed by two side-by-side declines (sloped tunnels to the ore deposit). The declines would start on the surface at the plant site at two locations referred to as mine portals (entrances to the underground mine). Each decline would be 20 feet (ft) wide by 20 ft in height (6 meters [m] by 6 m).

The surface projection of the extent of the underground workings and Maturi deposit is shown on Figure 2-1 and referred to as the underground mine area.

Underground Mine Construction Phase

In the underground mine, the construction phase would include the development of tunnels and installation of mine infrastructure. Tunnels, also known as drifts, would be excavated to access the ore, create initial production areas, establish ventilation, and provide access to backfill. Infrastructure would be installed in the underground mine including the material handling, ventilation, and dewatering systems.

The construction of the portals would start in Year -3. The portal would be drilled, blasted, loose rock would be removed, and the surface walls would be bolted to ensure safe access.

After the portals were completed, twin declines (sloped tunnels side-by-side) would be constructed to access the orebody. The declines would be excavated with a fleet of mobile equipment. The twin declines would provide for separate mine development and construction areas; fresh air; access for labor and materials; minimization of congestion; and an independent and exclusive decline for the main conveyor during the production phase. The length of the decline from the portal to the initial haulage level tie-in would be approximately 1.6 miles (2.5 km), to a depth of approximately 1,000 ft (300 m) below the surface.

The declines would be referred to by their use: conveyor decline and access decline. The conveyor decline would be the western decline and would contain the main conveyor that transfers ore from the mine to surface. This decline would eventually extend further down the deposit as mine development progresses. Construction of the conveyor decline and the access decline would begin simultaneously.

The access decline, east of the conveyor decline, would be used as the transport decline and would accommodate primary access and egress of miners, equipment, and materials to operate the underground mine. Traffic would be two-way, with crosscuts to serve as access to the conveyor decline for egress.

To support the underground workings, vertical mine passageways for ventilation would be excavated (ventilation raises). The ventilation raises would surface at three ventilation raise sites. The ventilation raises would vary in size from 17 ft to 20 ft (5.3 m to 6 m) and would be sized to meet the mine ventilation system requirements. To serve as a third exit from the underground workings, an Alimak elevator (or a comparable product) would be installed in one of the intake ventilation raises.

The ventilation raises would be constructed by raise bore technique. The raise bore technique utilizes a raise bore drill that drills a pilot hole from surface. The pilot hole would intersect the targeted drift underground and then a reamer would be attached to the drill shaft. The reamer would be sized to the final diameter of the ventilation raise. The drill would then pull the reamer from the underground drift to surface. The drilled rock would be removed from the bottom of the ventilation raise and handled by underground equipment.

Surface disturbance would be limited to the surface infrastructure associated with the three ventilation raise sites, as shown on Figure 3-4. Access to the ventilation raise sites would use existing U.S. Forest Service (USFS) roads, as well as existing drill roads, which would be upgraded as necessary.

The construction of the underground mine would be completed within 30 months. Construction activities would be conducted in accordance with the Minnesota Construction Stormwater General Permit, following best management practices (BMPs) in an agency approved Stormwater Pollution Prevention Plan (SWPPP).

Underground Mine Layout and Operational Activities

The following sections describe the mining method, the underground production cycle, backfilling, and underground support systems. Underground mine water management infrastructure is described in the section *Water Management Plan*.

Mining Method

The Project would mine the Maturi deposit using a longitudinal longhole retreat (LLR) mining method within five major mining productions zones as shown in Figure 3-5. Underground mining using the LLR mining method would target only those portions of the deposit considered ore, result in less excavation, and eliminate the need for aboveground waste rock stockpiles as only ore would be transported to the surface.

The LLR mining method would be classified as a stoping method; stoping is the process of extracting ore from an underground mine and leaving behind an open space called a stope. In the LLR mining method, stopes are mined longitudinally along the direction of the ore formation in a backwards fashion and separated by pillars that allow production from other mining units. Stopes would be accessed from different levels (drifts) and the diamond-shaped stope arrangements, conceptually shown on Figure 3-6 would allow for flexibility to have the stopes open for extended periods of time, up to multiple years, without backfill. This would reduce production risks, provide flexibility in managing the dry stack facility, and decouple backfilling from the mining cycle resulting in a more efficient and reliable operation.

Underground Production Cycle

The mining cycle is the process used to extract ore and includes the following five production steps: drilling, blasting, excavating, transporting, and crushing. First, stopes would be drilled from two different drifts creating the diamond shape. The drill holes would next be loaded with an explosive charge and primed. The blasting system would use remote detonation which would allow blasts to be initiated far from the blasting site. After blasting, load-haul-dump machines (LHDs) and trucks would load and transport the ore from the stope to an ore pass. A cross section of a typical conveyor drift and a typical transport drift is shown on Figure 3-7. The ore passes would direct the ore to a haulage level where LHDs or trucks would transport the ore to one of the underground semi-portable crushers. The crushed ore would be conveyed to the surface via the main conveyor housed in the conveyor decline. Primary mining equipment necessary to achieve the mining cycle is shown as Table 3-2.

Table 3-2 Primary Mining Equipment

Equipment	Fleet Count
Development Jumbo	5
Bolter	9
Loader 18 t	8
Loader 14 t	15
Haul Truck 30 t	5
Haul Truck 40 t	14
Easer	1
Uphold Production Drill	1
In-the-Hole Drill	4
Utility Cassette Carrier	5
Maximum Fleet Count	67

Abbreviations:
t = ton

Underground Backfilling

One of the benefits of the LLR mining method would be the ability to use waste rock and tailings as backfill, reducing the environmental footprint of the Project. Backfill would also limit rock falling / rock blasts and improve the long-term stability of the mine by providing confinement to the pillars between the stopes. Waste rock generated during underground mine development would remain underground and be backfilled into open stopes prior to the placement of engineered tailings backfill. The production of the engineered tailings backfill is described further in the section *Tailings Management Site Layout and Operational Activities*. Thickened tailings would be mixed with a binder for placement as engineered tailings backfill. During Project operation 33 million tons (30 million tonnes) of waste rock would be left underground and backfilled into empty stopes and 71 million tons (64 million tonnes) of engineered tailings backfill would be delivered underground for storage.

Underground Support Systems

To support the mining cycle, several other systems would be necessary, including ventilation and electrical.

The regulations of ventilation systems within underground mines in the United States are set by MSHA. The minimum airflow requirement for a diesel-operating mine is relative to its fleet size, with airflow calculated to provide sufficient air for diesel particulate matter dilution.

The ventilation system is designed to operate as a “push-pull” system whereby ventilation raise site 2 would function as the intake raise and ventilation raise site 1 and ventilation raise site 3 would function as the exhaust raises. Air would exhaust through the twin declines. Underground booster fans would be installed, as required, at the top of the fresh air transfer raises to support ventilation in the deeper part of the mine. Dedicated ventilation drifts and internal raises would be established to transfer fresh and exhaust air from the production levels to the ventilation raises. An image of the 25-year mine ventilation plan is shown on Figure 3-8. Due to the climate, some heating of the underground workings would be required from November through April.

To heat the mine, TMM would use propane gas-fired air heaters located on the surface at ventilation raise site 2. Fresh air would initially enter the heater station and pass through a direct-fired propane heater before being ducted to the main intake raise. A propane tank storage facility for the heater stations would be located in close proximity to both heater stations. The facility would include multiple propane tanks. Tank sizing and quantity would be determined by the contracted propane supply company and would be based on peak propane consumption for a minimum of three days.

Electrical power for the underground mine would come from the plant site electrical substation. Electrical feeders for the mine would be routed down the declines to the main underground electrical room. Feeders from the electrical room would distribute power to the major areas of the mine using tap boxes. Tap boxes would be used as connect points for mine load centers that would then feed the pumps, ventilation fans, production equipment, and development loads.

Underground Mine Reclamation, Closure, and Post-closure Maintenance

During reclamation, TMM would demolish surface ventilation structures. Foundations that are above-grade or buried 0 to 2 ft (0 to 0.6 m) below grade would be broken and buried in place and covered with a minimum of two feet of surface overburden. Below grade, non-vent shaft spaces would be filled with appropriate fill. Non-hazardous demolition debris would be removed and disposed of as deemed appropriate and in accordance with regulatory requirements.

Closure would include removal of underground mine equipment pursuant to Minn. R., 6132.3200.

To perform reclamation activities, the portals would remain open in order to deliver power and other utilities needed to complete the planned underground mine backfilling and remove underground equipment and infrastructure.

After removal of equipment and infrastructure from the underground workings, backfilled stopes would be allowed to passively fill with groundwater as groundwater levels progressively rise to pre-Project conditions after mine operations cease.

Access to underground workings would be closed off to the public throughout closure. Once closure activities in the underground workings have been completed and approved pursuant to federal and state regulations, fill would be placed within the upper segment of the declines and at the portal as a barrier to block mine re-entry. The barrier would be covered with a granular cover layer, above which rooting soil would be placed to support revegetation of the portal area.

Post-closure maintenance would consist of vegetation monitoring and monitoring the portal, ventilation raise sites, and above first 2,000 feet of mine decline to confirm closure integrity and lack of subsidence.

3.6.2.5 Plant Site

The plant site would receive the ore from the underground mine, process the ore to recover the target metals, and pump tailings to the tailings management site. It would also contain the portals which provide access to the underground mine.

Plant Site Construction Phase

Construction of the plant site would occur during the 30-month construction phase of the Project, from Q3 Year -3 to Q4 Year -1. The construction phase would include:

- Clearing the site;
- Managing rock from construction of the underground mine;
- Constructing the concentrator and other infrastructure; and
- Constructing the water management infrastructure (described in the section *Water Management Plan*)

The configuration of the plant site during construction is shown on Figure 3-9. An existing USFS one-lane gravel road would provide immediate access to the site, and during the construction phase an access road to the plant site would be built as described in the section *Access Road*.

Plant Site Clearing

In preparation for construction activities, the surface area at the plant site would be cleared, grubbed, graded, and filled as necessary. Material suitable as a growth medium such as topsoil and peat, would be stripped and stored in the reclamation material stockpiles for use during reclamation. Saleable lumber would be harvested and sold by a licensed third-party contractor. The remaining plant matter would be chipped and used to cover the reclamation material stockpiles to prevent wind and water erosion.

Rock Management During Construction

During construction of the underground mine, rock would be excavated, transported to the surface, and sorted into three categories: ore, waste rock, or construction rock. Rock category definitions are presented in the section *Overview of Rock Management*.

The construction rock would be used as construction aggregate after adequate characterization to prove its geochemical suitability. The construction rock transported to the surface would require processing to meet the construction aggregate specifications. The processing would occur on surface and include crushing and screening for classification of the aggregate. There would be requirements for construction aggregate across the plant site, tailings management site, non-contact water diversion area, and corridors to support construction. The requirement for construction aggregate occurs early in the construction phase, therefore construction rock stockpiles would be limited to what is necessary for operation of the crushing and screening to produce construction aggregate.

During the construction phase, ore and waste rock that does not meet the selection criteria for construction rock would be transported and temporarily stockpiled at the temporary rock storage facility. The temporary rock storage facility would be a lined facility with water management features (ditching and berms to control run-on and run-off) to capture stormwater for management as contact water; design features of the temporary rock storage facility are further discussed in the section *Rock Storage Facilities*.

The volume of the temporary rock storage facility would peak at the end of the construction phase. Once the concentrator is commissioned, ore and waste rock from the temporary rock storage facility would be crushed at a temporary surface crushing facility and fed into the primary ore stockpile for processing through the concentrator. The material in the temporary rock storage facility would be processed within the first two years of operating the concentrator, at which point the temporary rock storage facility would be reclaimed. A secondary ore stockpile would be constructed within a small percentage of the reclaimed temporary rock storage facility area. Ore would be intermittently stockpiled on the secondary ore stockpile; this facility is further discussed in the section *Rock Storage Facilities*.

Concentrator and Infrastructure Construction

On-site construction of the concentrator and infrastructure would begin in Q3 Year -3. TMM would target pouring foundations and erecting buildings in the summer and fall months. This would allow structural and mechanical installation to progress during the winter months. The concentrator would be commissioned in second half of Year -1 and would ramp-up production during the first year of operations. Some ore or rock may be required for commissioning individual processing circuits or mechanical completion checks, however first run-of-mine ore processed through all circuits in the concentrator and filter plant would denote the start of operations (Day 1 of Year 1) and the beginning of production ramp-up.

Other surface infrastructure necessary to support the Project, including service buildings, warehousing, water ponds, fencing, security, and parking, would be completed during the construction phase. Construction laydown areas would be designated within the plant site or tailings management site as appropriate.

Plant Site Layout and Operational Activities

The surface layout of the plant site as shown on Figure 3-10 would consist of:

- Portals (described in the section *Underground Mine*),
- Rock storage facilities
- Concentrator
- Plant site infrastructure
- Plant site water management infrastructure (described in the section *Water Management Plan*)

Surface mobile equipment that would support the concentrator and general surface operations is identified in Table 3-3. Note, the surface mobile equipment does not include mobile equipment for services that TMM plans to contract such as employee bussing, snow removal, and contracted mobile equipment.

Table 3-3 Surface Mobile Equipment at Plant Site

Equipment	Number of Units
Tool Handler	1
Bobcat	1
Pick-up Truck	11
Boom Truck	1
Front-end Loader	1
Electrician Vehicle	1
30 t Mobile Crane	1
Grader	1
Water Tanker	1
Vibratory Packer	1
Ambulance	1
Fire Truck	1

Abbreviations:
t = ton

Rock Storage Facilities

There would be three rock storage facilities on the surface: the temporary rock storage facility, the primary ore stockpile the secondary ore stockpile.

Temporary Rock Storage Facility

Ore and waste rock that does not met the selection criteria for construction rock extracted from during the construction stage would be trucked from the underground mine and stockpiled within the temporary rock storage facility. The temporary rock storage facility would be a lined facility with water management features that would capture precipitation on the footprint of the facility and direct it to plant site pond 2.

Once the concentrator is commissioned and ready to process ore, a front-end loader would place the stockpiled ore and waste rock into temporary crusher feed bins that directs material into the mobile jaw crusher (together called the temporary surface crushing facility) which would be located next to the temporary rock storage facility. The crusher would place material onto the reclaim conveyor that leads to the transfer station before being placed on the primary ore feed conveyor, joining the run-of-mine ore and finally feeding the primary ore stockpile. BMPs such as water sprays to control dust and the containment of materials at the temporary rock crushing facility would be included.

The temporary rock storage facility would be temporary and at its largest size (1.2 million short tons) at the end of the mine construction period. The material within the temporary rock storage facility would be consumed through the concentrator within the first two years of operations and the area reclaimed or repurposed.

Primary Ore Stockpile

The concentrator would be fed ore from the primary ore stockpile where it would be reclaimed by the primary ore reclaim conveyor (also known as the semi-autogenous grind (SAG) mill feed conveyor). The primary ore stockpile would primarily be fed by ore from the decline conveyor but would also be supplemented with rock from the temporary rock storage facility during the first two years of operation and intermittently supplemented with ore from the secondary ore stockpile during operational years three through 25.

The primary ore stockpile would have a concrete working floor with a reclaim area in a concrete tunnel underneath the working floor, and a covered geodesic dome structure. The primary ore stockpile would be approximately 94 ft and would have a capacity to store up to 3 days of crushed ore. A typical cross-section of the primary ore stockpile is shown on Figure 3-11. Covering the primary ore stockpile would reduce dust emissions, prevent infiltration of precipitation into the ore, and reduce the risk of ore freezing during winter operations.

Material from the primary ore stockpile would be fed into the concentrator via the SAG mill feed conveyor; the conveyor would be equipped with a weather cover. Ore stored in the primary ore stockpile would already be crushed (crushing would occur underground) and would be fed directly to the SAG mill within the comminution circuit without any additional size reduction required. The primary ore stockpile's geodesic dome has been specially designed to reduce the visibility of the dome by locating the dome beneath the primary ore stockpile feed conveyor.

Secondary Ore Stockpile

The secondary ore stockpile would operate with a capacity up to 2.5 days of crushed ore and would be used intermittently throughout the mine operation.

The secondary ore stockpile would be fed crushed ore from the main decline conveyor: a conveyor transfer system has the ability to divert ore from the main decline conveyor to the secondary ore stockpile feed conveyor. During operations when the primary ore stockpile is temporarily full, crushed ore would be diverted to the secondary ore stockpile feed conveyor and conveyed to the secondary ore stockpile. Ore from the secondary ore stockpile would be rehandled by front end loader, loaded onto a conveyor, transferred to the primary ore stockpile feed conveyor and conveyed to the primary ore stockpile. The secondary ore stockpile would exist intermittently, based on the maintenance schedule of both the underground mine and the concentrator. The purpose of the secondary ore stockpile would be to decouple the underground mine and concentrator during shutdowns. Shutdowns would occur due to both planned and unplanned maintenance activities. Based on preliminary review of downtime, it is expected that the secondary ore stockpile would be present at various times adding up to a total of 2-6 months over the calendar year. Over the 2-6 months, the stockpile averages approximately

10,000 tons (9,072 tonnes) and not the peak volume of 2.5 days which equates to approximately 50,000 tons (45,360 tonnes).

The secondary ore stockpile would be a lined facility with water management features that would capture precipitation on the footprint of the facility and direct it to plant site pond 2. From plant site pond 2, the water would be pumped to the process water pond. The water management features are further discussed in the section *Contact Water Management*.

Concentrator

The concentrator includes the comminution circuit, gravity concentration circuit, the flotation circuit, concentrate dewatering and storage, and the reagent make-up area.

The concentrator would produce three saleable concentrate products (the separated metals) and tailings (the remaining ground rock after targeted metals are recovered). The concentrator includes a series of processes in the comminution circuit, the gravity concentration circuit, and the flotation circuit, that would produce the three final products, the copper concentrate, the nickel concentrate, and the gravity concentrate.

The copper concentrate is the first flotation product and would recover copper, gold, silver, platinum, and palladium while minimizing the amount of nickel and cobalt recovered. The nickel concentrate is the second flotation product and would recover nickel, cobalt, the remaining copper, platinum, palladium, gold, silver, and the remaining sulfides. The gravity concentrate would target the recovery of platinum, palladium, and gold.

Tailings would be transported by pipeline from the concentrator to the tailings dewatering plant at the tailings management site. A processing flowsheet is shown on Figure 3-12.

Comminution Circuit

In the comminution circuit, ore that had first been crushed underground would be further ground down to a size which enables the separation of the targeted minerals from gangue minerals. The comminution circuit would be fed by a conveyor from the primary ore stockpile. The grinding occurs in two stages, a coarse grind in the SAG mill, followed by closed circuit grinding in the ball mill to achieve the target particle size for flotation.

The SAG mill would use grinding balls to aid the grinding of the ore. The discharge from the SAG mill would be screened and oversized ore would be reintroduced to the SAG mill until it passes the target size. Ore that passes the target size would be sent to the ball mill for further grinding. After the ball mill, the ore would feed the ball mill cyclone which would separate the ore into two streams: the overflow and the underflow. The overflow (finer grained material that has met the target size) from the ball mill cyclone would be sent to the flotation circuit. Underflow (coarser grained material that has not met the target size) from the ball mill cyclone would be recirculated to the ball mill feed. One third of the stream recirculated to the ball mill would be split to feed the gravity concentration circuit; the gravity concentrate tails would be added back to the ball mill recirculating stream.

Gravity Concentration Circuit

The gravity concentration circuit would be used to recover platinum, palladium, and gold from the ball mill cyclone feed. The gravity concentrate units would be fed by a split stream of the ball mill recirculating load and the gravity tails returned to the same spot after processing through the gravity concentration unit. Gravity concentration uses the differences in the density of the gold, platinum, and palladium minerals to separate the ore from the gangue minerals. After gravity concentration, the gravity concentrate would be dewatered and bagged in preparation for shipment.

Flotation Circuit

After the ore has gone through the comminution circuit and hit the target size it would be conveyed to the flotation and regrind circuit. Flotation is the process for selectively separating hydrophobic materials (repelled by water) from hydrophilic materials (attracted by water). This process would separate the valuable minerals from the gangue. In the flotation and regrind circuit the ore would first be fed into a copper rougher bank with different reagents used to separate the ore into a copper-rich concentrate (copper rougher concentrate) and a copper-poor tails (copper rougher tails). The copper rougher concentrate would be pumped to the copper regrind mill and the copper rougher tailings would be sent to the nickel rougher bank.

The copper regrind mill would grind the ore further and would feed the copper cleaner circuit. The copper cleaner circuit would further reject gangue while recovering copper minerals to create the final copper concentrate. This final copper concentrate would be pumped to the copper concentrate thickener.

Copper rougher tailings would feed the nickel rougher bank of cells which would work much like the copper rougher bank of cells. Reagents would be added to the nickel rougher feed tank and the ore would be split into nickel-rich concentrate (nickel rougher concentrate) and a nickel-poor tails (nickel rougher tails). The nickel rougher concentrate would feed the nickel concentrate regrind mill and the nickel rougher tailings would be sent to the tailings dewatering plant.

The nickel regrind mill would grind the material further and would feed the nickel cleaner circuit which would produce the final nickel concentrate. The nickel final concentrate would feed the nickel concentrate thickener.

Concentrate Dewatering and Storage

The final concentrates would be dewatered by dedicated concentrate thickeners and filter presses. The dewatering process would remove water from the concentrates to a suitable moisture content that they can be placed in sealed containers for transport by truck to the Port of Duluth where the concentrate can be transferred for additional transport by rail or ship.

Reagents Make-up Area

Multiple reagents would be used in the flotation, thickening, and backfilling circuits. Reagents would be mixed and stored before use in a building connected to the flotation area of the concentrator. Lime would be stored in a silo outside of the reagent make-up area building and would be integrated with the detention slaker.

Plant Site Infrastructure

The plant site infrastructure would include the mine services building, the concentrator services building, the plant site electrical substation, the explosives magazine, the tailings supply line, and ancillary supporting infrastructure. Plant site surface infrastructure would also include the process water pond and plant site ponds 1 through 3 that are discussed in the section *Water Management Plan*.

The mine services building would include offices, meeting space, truck shop, mine dry, weld shop, wash bay, and warehouse. The mine services building would be centrally located and would be shared by technical services, supervision, and hourly labor for the Project.

Fuel, diesel, and gasoline for the plant site would be stored near the mine services building within the fuel storage area. Additionally, a gasoline tank would allow fueling of surface equipment and / or light vehicles. Engine oil and lubricants would be provided in oil cubes and stored in dedicated areas near the mine services building. A waste storage area adjacent to the mine service building would be used to stage waste prior to pick up by a contractor for off-site disposal.

The concentrator services building would include training and meeting rooms, offices, concentrator dry, maintenance workshop, machine shop, and warehouse. The concentrator services building would be located near the concentrator and would provide a workshop to perform routine and non-routine maintenance on process equipment, as well as store critical and non-critical spares on site. An additional reagent storage area would be included northwest of the concentrator services building. The domestic water source required to provide the services described in the mine services building and concentrator services building has not been identified. Preliminarily considerations include a domestic water plant that would source water from Birch Lake. Potable water source has not been identified; preliminary considerations for potable water would include transport water jugs to site.

The plant site electrical substation would distribute power via underground raceways, cable trays, and overhead power lines. Electrical equipment, motors, control panels, field devices, relays control system components, and cabling systems would be approved for the conditions in which the equipment would be installed.

Site emergency power would be provided through standby power generators rated for the maximum power required in the event of a utility power failure; the standby power generators would be sized to provide approximately 2.5 MW but would be updated as deemed necessary to reliably provide site emergency power. Emergency power loads would be controlled by a control system, which would automatically start and stop loads to keep process pumps operating to prevent spills and overflows, keep tanks properly agitated, and run the equipment, such as fans for safe ventilation.

Telecommunications service would be required to support the Project. The delivery of telecommunications is still being studied. Potential options for connecting to existing telecommunications network include, providing service through a cable routed with the transmission corridor, providing service through a cable routed with the access road corridor, or satellite service options.

Explosives would be stored in the explosives magazine, located in the northwestern corner of the site, prior to transport underground. Storage and transport of explosive materials would be done in accordance with regulations of the Mine Safety and Health Administration, the Bureau of Alcohol, Tobacco, Firearms and Explosives, and the Minnesota State Fire Marshall.

The tailings supply line, through which tailings would be transported from the concentrator to the tailings dewatering plant at the tailings management site, would be routed alongside the internal site road connecting the plant site and the tailings management site along with power, water supply, and water return lines.

Suitable growth medium, consisting of topsoil, mineral soil, and peat stripped during construction would be stockpiled for reclamation in two reclamation material stockpiles at the plant site. Stripping at the plant site is estimated to produce 111,000 cubic yards (yd^3) (85,000 cubic meters [m^3]) of material.

Plant Site Reclamation, Closure, and Post-closure Maintenance

Reclamation of structures and supporting infrastructure would generally include salvage (when practicable / feasible), demolition, disposal, and restoration. All buildings associated with the Project would be demolished unless a post-mining onsite use is identified and approved by the appropriate regulatory and land management agencies that would benefit from the infrastructure. Some of the building materials would be salvageable and would be removed from the site.

Building foundation walls and equipment foundations that are above-grade or buried 0 to 2 ft (0 to 0.6 m) below grade would be broken and buried in place and covered with a minimum of two feet of surface overburden. Foundations greater than 2 ft (0.6 m) in depth are proposed to be left in place. Below grade spaces would be filled. Building areas would be graded to promote proper runoff and drainage. Pond liners and other debris would be hauled to a licensed landfill for disposal. Additional soil cover would be imported as needed to provide sufficient soil cover thickness over remaining buried infrastructure. The sites would be covered with growth media and revegetated to establish a land use similar to adjacent undisturbed lands.

It is anticipated the majority of the demolition waste (material not salvageable, saleable, recyclable, or reusable) from removal of structures would be acceptable for disposal in a new (location to be determined) or existing demolition debris landfill. Any remaining concentrate would be shipped to customers. Reagent suppliers, which would be under contract to TMM, would remove reagents remaining at the closure stage of the Project. Solid waste and industrial solid waste would be managed per state regulations and requirements. Other special materials - defined as those materials not classified as demolition debris, not classified as solid waste, and not a RCRA-regulated material - on site at the time of closure may include nuclear sources, partially used paint, chemical and petroleum products, fluorescent and sodium halide bulbs, batteries, electronic waste, lighting ballasts, and small capacitors. These materials would be safely collected, removed, and properly recycled or disposed.

The post-closure surface of the plant site would be graded to drain toward adjacent wetland complexes and would generally re-establish pre-Project flow directions and discharge locations. Reclamation design would aim to create conditions where runoff rates and volumes estimated for stormwater reaching downstream surface water receptors are similar to pre-mining site conditions.

After grading, topsoil from stockpiles would be spread across the plant site to create a growth medium for revegetation. The reclamation material stockpile locations would be regraded to match post-closure contours.

Reclamation of the plant site would include use of water management infrastructure to control erosion and stormwater quality, quantity, and rates. Once the planned plant site post-closure surface topography is established, reclamation cover materials that would serve as a growth medium for revegetation would be placed. Plant communities selected for revegetation would be confirmed based on reference site and revegetation plot findings. Until then, plant communities have been selected considering climate change and the anticipated evolution of plant communities in the project region. The target plant community at the plant site would include a range of mixed hardwood pine forest to jack pine barrens.

Post-closure maintenance would consist of vegetation monitoring and monitoring to confirm performance of stormwater and erosion control.

3.6.2.6 Tailings Management Site

The tailings management site would have three main components, as shown on Figure 3-13:

- The tailings dewatering plant, which would produce both the engineered tailings backfill for the underground workings and a tailings filter cake for the dry stack facility;
- The dry stack facility which would provide permanent above ground storage for the tailings filter cake; and
- The reclamation material stockpile which would stockpile suitable growth mediums stripped from the dry stack facility footprint until use in concurrent reclamation.

Tailings Management Site Construction Phase

The construction phase at the tailings management site would include:

- Clearing;
- Construction of the tailings dewatering plant;
- Construction of the dry stack facility; and
- Construction of water management infrastructure (described in the section *Water Management Plan*).

Tailings Management Site Clearing

Clearing at the tailings management site would use the same methods described in the section *Plant Site Clearing*.

Tailings Dewatering Plant Construction

Construction of the tailings dewatering plant would use the same methods and managed under the same schedule described in the section *Concentrator and Infrastructure Construction*.

Dry Stack Facility Construction

The dry stack facility would be developed in three stages from west to east and development would occur during the construction phase and continue through the 25 years of the operation phase. Each stage begins by constructing the dry stack facility infrastructure followed by placement of the tailings. Placement of the tailings on the dry stack facility would occur during operations and would involve trucking tailings filter cake for placement on the dry stack facility where it would be dozed into place and compacted with mobile equipment. The tailings would be compacted to a compaction requirement of 95% standard proctor maximum dry density for the structural zone and 90% standard proctor maximum dry density for non-structural zone. The following discussion relates to the construction of the dry stack facility infrastructure which would include liner system (under-liner drains, geomembrane liner, and over-liner drains), dry stack facility perimeter ditch, dry stack facility runoff collection ditch, groundwater cutoff wall, haul road, and associated tailings management site ponds.

Construction of the dry stack facility infrastructure would start on the west side of the tailings management site and progress east, with each stage covering approximately one third of the total area, as shown in Figure 3-14. This staged approach would minimize the footprint of the dry stack facility for as long as practical to delay impacts related to clearing and grubbing. Construction of dry stack facility stage 1 infrastructure would begin in Q3 Year -3 and be completed at the end of the construction phase at Q3 Year -1.

For each phase of dry stack facility infrastructure construction, vegetation would be cleared and grubbed, standing water would be drained, and the subgrade would be prepared by removing sharp rocks and other debris and then proof-rolling the foundation subgrade soils. The majority of the area is expected to be fill, however localized blasting may occur in high reliefs areas and sections of the dry stack facility perimeter ditches may be blasted depending on elevation. If there are areas where bedrock is exposed, bedrock would be covered with a minimum 6 inch (15 millimeter [mm]) thick bedding layer of compacted local borrow material.

After preparing the subgrade in each phase of dry stack facility construction, a liner system would be installed, as described in the section *Water Management Plan*. Surrounding the lined area of the dry stack, the dry stack facility perimeter ditch, dry stack facility runoff collection ditch, groundwater cutoff wall, and haul road would be installed around each dry stack facility stage, as described in the section *Water Management Plan*. Additionally, the tailings management site ponds and interim ponds would be installed as described in the section *Water Management Plan.*

Tailings Management Site Layout and Operational Activities

The final surface layout of the tailings management site, as shown on Figure 3-13 would consist of:

- Tailings dewatering plant;
- Dry stack facility;
- Reclamation material stockpile; and
- Components of the Project's water management infrastructure (described in the section *Water Management Plan*).

Tailings Dewatering Plant Layout and Operational Activities

The tailings dewatering plant would be compact and located directly south of the plant site. Tailings dewatering plant infrastructure would include tailings dewatering plant pond 1 as described in the section *Water Management Plan*.

The tailings dewatering plant would dewater the tailings from the concentrator to produce the tailings filter cake to be stored in the lined dry stack facility and the engineered tailings backfill to be pumped back into the underground workings. The tailings filter cake produced by the filter plant would be a dry (13 to 16 % moisture) silty, sandy material which would be hauled by dump truck to the dry stack facility and piled for permanent storage. The engineered tailings backfill would be created by mixing thickened tailings, tailings filter cake, and a binder to achieve the desired engineered tailings backfill consistency to be pumped underground and placed in mined out stopes. The binder would increase the structural integrity, minimize movement of water, and enhance the chemical stabilization of the engineered tailings backfill. Backfilling is discussed further in the section *Underground Mine Layout and Operational Activities*.

The tailings dewatering plant would consist of

- Tailings thickener;
- Filter plant – which would produce filter cake;
- Filter cake storage and loadout building; and
- Backfill plant – which would produce engineered tailings backfill.

The tailings thickener would receive tailings from the nickel rougher, pumped through the tailings supply line from the concentrator. The tailings supply line would follow a road connecting the plant site and the tailings management site routed along with power, water supply, and water return lines. At the tailings thickener a flocculant reagent would be added to aid in the settling and dewatering of the tailings. Directly to the northeast of the tailings thickener is the emergency pond which would be used to empty the tailings thickener during an operational shutdown in the event that it cannot be pre-emptied. The emergency pond would be lined with a 60 mil HPDE or engineer-approved alternate geomembrane liner over a 1-ft (300-mm) thick, low-permeability, compacted soil liner; the soil layer would be compacted to meet maximum hydraulic conductivity requirements of not more than 1×10^{-6} centimeters per second (cm/sec).

The thickened tailings would be routed to the filter plant or the backfill plant. The Project would be capable of producing 100% tailings filter cake for the dry stack facility, 100% engineered tailings backfill, or different portions of each. The proportion of thickened tailings sent to the filter plant and to the backfill plant would vary depending on the operational needs of the Project.

The filter plant would consist of filter feed tanks, process water holding tanks, pressure filter presses, and ancillary equipment including air compressors, pumps, and tanks. The filter units would receive thickened tailings slurry from the tailings thickener via feed tanks and produce a filter cake in the target range of 84% to 87% solids. The filter cake would be transported via covered short-run conveyors to either the backfill plant or the filter cake storage and loadout building.

The filter cake storage and loadout building would receive filter cake from the filter plant via a conveyor and house a stockpile with up to 1.5 days of tailings storage capacity as a filter cake. The stockpile would be enclosed in a heated building to prevent freezing. Front-end loaders would transfer the stockpiled tailings filter cake into haul trucks for transport to the dry stack facility. A haul road would connect the filter cake storage and loadout building and the dry stack facility. The Project would be engineered to handle periods of upset that may occur resulting in the production of off-spec tailings filter cake. This would be accomplished by both ensuring that the filter presses are properly sized and engineered with enough design capacity and an operational flexibility that would allow disposal of tailings as an engineered tailings backfill or tailings filter cake.

The capacity of the filter cake storage and loadout building would be 33,000 tons (30,000 tonnes) which would equate to approximately 36 hours of filter cake storage capacity at full production. The filter cake storage and loadout building would only be utilized to temporarily store filter cake before it is loaded onto trucks to be placed on to the dry stack. This building would be utilized to store filter cake between shifts when trucking, placement and compaction may not occur (a maximum of 12 hours) and when environmental conditions wouldn't allow for trucking and placement onto the dry stack. If environmental conditions would prevent trucking and placement onto the dry stack for more than a few hours, preparations would be made to switch tailings disposal to backfill deposition underground. When backfilling, the filter cake storage and loadout building would not be utilized. Since TMM has the flexibility to deposit tailings underground as a backfill, the filter cake storage loadout building would be able to be smaller as it doesn't need to store filter cake for the full durations of weather events or equipment downtime.

The backfill plant would consist of mixing tanks, binder preparation, and the main pumps for delivering engineered tailings backfill to the underground workings. The backfill plant would blend thickened tailings slurry from the tailings thickener and tailings filter cake from the filter plant. It would also prepare the binder, using process water. The combined stream would be mixed with the binder to achieve a desired consistency and then pumped to the underground workings via the engineered tailings backfill pipeline. Backfilling in the underground workings is described in the section *Underground Backfilling*.

<u>Dry Stack Facility Layout and Operational Activities</u>

The lined dry stack facility would be used to permanently store approximately 60% of the tailings with a total storage capacity of 106 million tons (96 million tonnes) and an operational life of 25 years. The dry stack facility would average 130 ft tall with a crest elevation of 1,621 ft above mean sea level (amsl) at full development. The footprint of the dry stack facility at full development would be approximately 429 acres (174 ha [hectares]).

The exterior side slopes of the dry stack facility would have 16 ft (5 m) wide benches at 46 ft (14 m) vertical intervals. The exterior slopes would have an overall slope of 4H:1V. The filtered tailings would be compacted and placed at grades and contours that would promote drainage, prevent ponding, and remain stable in post-closure.

The dry stack facility would be a lined facility (over-liner drain, geomembrane liner, and under-liner drain) and include a groundwater cutoff wall around the entire dry stack facility footprint. Additional discussion on water management at the dry stack facility is provided in the section *Contact Water Management*.

Dry stacking of tailings filter cake coupled with placement of engineered tailings backfill underground increases the flexibility of the overall tailings management system. Generally, tailings filter cake would be placed in the dry stack facility in the spring, summer, and fall. Tailings would be compacted prior to freezing, therefore during the winter, tailings would primarily be deposited underground as engineered tailings backfill. Placement at the dry stack facility during wet periods or during cold periods (below 5 degrees Fahrenheit) would be avoided as much as practicable. Placement of tailings filter cake at temperatures below 5 degrees Fahrenheit increases the likelihood of re-handling and re-compaction and thus preference would be to avoid placement at that time.

During dry stack facility operation, tailings filter cake would be hauled from the filter cake storage and loadout to the dry stack facility on a dedicated perimeter haul road then on to temporary haul roads and ramps on the dry stack facility. Haul trucks would dump the tailings filter cake to bulldozers that would push and shape the material. Compactors would compact the material, and water trucks would be used to control fugitive dust. A list of mobile equipment necessary to support the dry stack facility is listed in Table 3-4.

Table 3-4 Surface Mobile Equipment at Tailings Management Site

Equipment	Stage 1	Stage 2	Stage 3
60 Ton Trucks	10	11	12
Front End Wheel Loader	3	3	3
Vibratory Roller Compactors	3	3	3
Dry Stack Facility Dozers	3	3	3
Graders	2	2	2
Water Trucks	3	3	3
Bob Cat	2	2	2
Fork Lift	2	2	2
Flat Bed Truck	2	2	2
Pickup Truck	5	5	5

The dry stack facility would be concurrently reclaimed during the operation phase, as described in the section *Tailings Management Site Reclamation, Closure, and Post-closure Maintenance*.

The dry stack facility would be constructed in stages with Stage 2 and 3 constructed during the operation phase. Stage 1 would be completed during the initial Project construction phase, discussed in the section *Dry Stack Facility Construction*, and would accommodate Year 1 to 6 of dry stack facility operation. Stage 2 construction would start in Year 5 of Project operation and last approximately 24 months. The construction would follow the same designs and plan as Stage 1. Stage 2 would accommodate Year 7 to 15 of dry stack facility operation. Stage 3 construction would follow the same designs, plans, and timeline as Stage 2, and stage 3 would accommodate the remainder of dry stack facility operation.

Two-dimensional stability analysis was conducted using a typical cross-section of the dry stack facility structure and foundation design. The analyses considered a number of scenarios including construction (with elevated pore pressures), long term static, post liquefaction and pseudo-static seismic loading. The stability analyses were used to inform the design of the dry stack facility embankment geometry and foundation treatments and to confirm that the dry stack facility design meets required factors of safety for stability during operations and closure. The dry stack facility would have a structural zone that consists of placed and compacted filtered tailings under the sloping exterior perimeter slopes and crest of the dry stack facility. This structural zone would be compacted to a minimum nominated compactive effort and governed by quality control guidelines to provide sufficient strength to ensure a safe and stable landform. The non-structural zone within the interior of the dry stack facility would also comprise compacted filtered tailings, though to a lesser standard of compaction compared to the structural zone. Tailings placed within this zone would not have a material impact on the global stability of the dry stack facility, however compacting of the tailings would provide trafficability and stability for working surfaces and slopes and would also reduce the required storage volume of tailings filter cake for the Project.

Based on the dry stack facility design and initial stability analysis, buttressing would not be required. The purpose of buttressing is to increase resistive forces at the toe of a slope. This can be an effective solution when a slope is too steep or when shear stresses have already mobilized along a failure plane. Another means of improving slope stability is to flatten a slope. The dry stack facility design of the 4H:1V exterior slopes and well-compacted tailings in the structural zone have shown, through limit equilibrium analysis, that the dry stack facility would meet target design factors of safety and provide long term stability around the perimeter of the dry stack facility. The exterior slopes were flattened to provide a stable embankment slope that would not only meet or exceeds slope stability requirements but would also limit erosion potential and support the establishment and long-term sustainability of a vegetated reclamation cover. The design of the 6H:1V interior (temporary) slopes would provide a stable working surface for the dry stack facility within the non-structural interior. If any weak, compressible, or loose soils would be identified the foundation of the dry stack facility, these undesirable soils would be excavated and hauled to the reclamation material stockpile for use in closure.

Tailings Management Site Reclamation Material Stockpile

Suitable growth medium, consisting of topsoil, minerals soil, and peat would be stripped during subgrade preparation and stored separately in the reclamation material stockpile area. Based on estimates of the unconsolidated deposit down to bedrock, 1,380,000 yd^3 (1,055,000 m^3) of material would be stripped and stockpiled over the three stages of dry stack facility construction. The dry stack facility would be reclaimed concurrently with the reclamation material stockpile reaching maximum size at year 16 and 871,000 yd^3 of material stored. The reclamation material stockpile would have a 50 ft maximum height above original topography and have a 3H:1V slope.

Tailings Management Site Reclamation, Closure, and Post-closure Maintenance

Buildings at the tailings management site would be reclaimed following the same procedures outlined in the section *Plant Site Reclamation, Closure, and Post-closure Maintenance*, specifically salvage (when practicable / feasible), demolition, disposal, and restoration.

The dry stack facility would be concurrently reclaimed throughout the Project operation phase. As portions of the slope and crest of the dry stack facility are constructed, the completed surfaces would be concurrently reclaimed with a cover. Concurrent reclamation, and post-closure management of the dry stack facility are described in the section *Water Management Plan*.

Post-closure maintenance at the tailings management site would consist of:

- Vegetation monitoring;
- Confirmation of stormwater management and erosion control performance;

- Dry stack facility seepage water management (if any);
- Surface water and groundwater quality monitoring; and
- Dry stack facility piezometer and inclinometer monitoring.

3.6.2.7 Non-contact Water Diversion Area

The non-contact water diversion area would be a series of diversion dikes and ditches to divert water from adjacent watersheds around the plant site and tailings management site. The non-contact water diversion area is described in the section *Water Management Plan*.

3.6.2.8 Access Road

The access road would extend from Highway 1 to the northern edge of the plant site as shown in Figure 2-1. This alignment was selected to minimize wetland impacts and avoid identified cultural resources. The road would be a two-lane gravel road with a maximum speed of 30 miles per hour (mph) and 14 ft- (4.3 m) wide lanes designed for a tractor-trailer rig. The access road construction limits would be approximately 200 ft (61 m) wide, depending on corridor grading limits. Ditches would control stormwater with culverts sized to accommodate a 100-year, 24-hour storm event. Access would be controlled by a staffed entry on the northern edge of the plant site. Typical access road sections are provided on Figure 3-15.

The access road would be constructed during the construction phase and would be prioritized so access during construction can transition from the USFS road to the access road as soon as practical. Access road construction would be conducted in accordance with the Minnesota Construction Stormwater General Permit and follow the BMPs in an agency approved SWPPP.

Through reclamation and closure, the access road would be left in place and maintained. Maintenance and / or reclamation of the access road after closure would be based on future land use and access needs.

3.6.2.9 Water Intake Corridor

The water intake corridor would contain the infrastructure needed to transport water from Birch Lake to the plant site, including a pipeline, power line, and maintenance road. It would extend from the northwestern corner of the plant site to Birch Lake approximately 3,000 ft (914 m) to the west, as shown on Figure 3-16. The water intake corridor construction limits would be approximately 100 ft (30.5 m) wide, depending on corridor grading limits. A water intake pump house would be located 100 ft (30.5 m) from the ordinary high water level elevation of 1419.99 ft (432.8 m) for Birch Lake. From the intake pump house, a water intake pipeline (approximately 18 inches in diameter) would be installed underground and a screened low-flow intake would extend out 550 ft (170 m) away from the shore of Birch Lake. The intake pipe would enter the water a minimum of 3 ft (1 m) below the water level, lay on the bottom of the lake, and draw water from a depth of 15 ft (4.5 m) as shown on Figure 3-17. The end of the water intake pipeline within Birch Lake would be screened and have a low-flow intake (0.5 feet per second or less). A vegetative screen surrounding the pumphouse would minimize visibility of the water intake corridor from Birch Lake.

Water intake corridor construction would take place during the construction phase. Construction would be conducted in accordance with the Minnesota Construction Stormwater General Permit and follow the BMPs in an agency approved SWPPP.

During reclamation, saleable equipment or salvageable materials at the water intake facility would be removed and transported to an approved landfill for disposal or abandoned in place, either of which would be subject to required site closure provisions. The pipeline and power line connecting the water intake facility to the plant site would also be removed, and if not saleable or salvageable, would be transported to an approved landfill for disposal.

3.6.2.10 Transmission Corridor

To supply electrical power to the Project, a transmission corridor would be constructed from the plant site to the south, turning west and terminating at the west side of the Dunka Pit at an off-site electrical substation, as shown on Figure 2-1. The transmission corridor would be approximately 10 mi (16 km) long and construction limits would be approximately 150 ft (46 m) wide, depending on corridor grading limits. Transmission corridor maintenance width would be 150 ft or less. Transmission line structures would be placed in such a way as to avoid wetlands and sensitive habitats.

The transmission corridor would include a two-track, unpaved maintenance road and the power transmission line, which would originate from an off-site electrical substation and terminate at the plant site electrical substation. The two-track maintenance road would be accessed from existing local roads and would not require culverts or bridges. The two-track maintenance road would be accessed from existing local roads and it is anticipated that it would not require culverts or bridges. At the off-site electrical substation, the Project transmission line would connect to an existing transmission line, and a regional power provider would supply the Project with power. The transmission line would feed the plant site electrical substation, described in the section *Plant Site Infrastructure.* Grid power would be delivered at the start of Year -1.

The transmission corridor would be constructed from Q4 Year -2 to Q4 Year -1, with the primary construction window expected to be from March through October, excluding river and wetland crossings, where winter is preferred to utilize frozen ground and dormant wildlife and vegetation. Construction is expected on two work fronts: one starting at the plant site; and one starting at the off-site electrical substation.

At closure, overhead electric transmission lines providing power to the plant site and tailings management site would be disconnected from Project infrastructure. Transmission lines would be removed or provisions would be made for continued subsequent use pursuant to Minn. R., 6132.3200 subp. 2 E.

3.6.2.11 Water Management Plan

TMM would manage water to avoid and reduce potential environmental impacts from the Project. Water management systems would be designed to prioritize water reuse to reduce Project demand for fresh water. The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water.

Water would be managed according to its water quality, as seven types of water:

- Process water - water used in the concentrator to process the ore. This would include engineered tailings backfill bleed water before it mixes with mine inflow, water used for processing at the concentrator, and water removed from the tailings at the tailings dewatering plant. Process water would be recycled to the lined process water pond and reused as process water;
- Mixed water - a mixture of process water and one or more other types of water. Managed as either process water or contact water, depending on its properties. This would include underground mine water and water collected by the dry stack facility over-liner drains;
- Contact water - water that comes in direct contact with ore or waste rock (except construction rock) or infiltrate into tailings. Contact water would be routed to lined ponds, then used as process water;
- Industrial stormwater - direct precipitation, precipitation runoff, stormwater runoff, snowmelt runoff, and surface runoff and drainage that has contacted industrial areas or activities that could have increased constituent loading and is not process water, contact water, or mixed water. This would include stormwater and snowmelt runoff from the surface of dry stack facility tailings assuming such water is in compliance with applicable standards. This would also include stormwater from portions of the plant site and tailings dewatering plant. Industrial stormwater would be routed to industrial stormwater ponds;
- Non-contact water - direct precipitation, stormwater, and surface water that has not contacted ore, waste rock, tailings, industrial areas or activities, or surface disturbed by construction, including runoff from reclaimed surfaces and water from adjacent watersheds diverted around the facility. This would include stormwater from undisturbed portions or reclaimed portions of the Project area. The general approach in managing non-contact water is: 1) to prevent external non-contact water from mixing with and therefore becoming contact water or industrial stormwater; 2) to minimize scour and erosion potential; and 3) to minimize total suspended solids (TSS) and other constituents prior to discharge to surface water;
- Construction stormwater - direct precipitation, precipitation runoff, stormwater runoff, snowmelt runoff, and surface runoff and drainage that has contacted surfaces disturbed by construction activities that could have increased constituent loading; and
- Construction dewatering water - surface water and groundwater removed to dry and/or solidify a construction site to enable construction activity.

Stormwater, in this document, means stormwater runoff, snow melt runoff, surface runoff, or drainage (consistent with Minn. R. part 7090.0080 subp.12).

This Water Management Plan summarizes management of process water, mixed water, contact water, industrial stormwater, and non-contact water during the operation phase, as well as management of construction stormwater and construction dewatering water.

Process Water Management

Process water would be managed in the underground mine, at the plant site, and at the tailings management site. Process water would be reused as process water to meet concentrator demand; thus, process water is managed in a closed loop with no discharge.

This section describes the flows of process water across the Project, then details the process water management infrastructure at the underground mine, plant site, and tailings management site.

Description of Process Water Flows

The process water management strategy would be to obtain water for processing according to the following priority list:

1. Reuse of process water;
2. Use of mine inflow (classified as mixed water because contact water would combine with process water in the underground mine dewatering system);
3. Use of draindown (classified as mixed water);
4. Use of direct precipitation and stormwater that is captured as contact water;
5. Use of direct precipitation and stormwater that is captured as industrial stormwater; and
6. Make-up water from Birch Lake (withdraw from Birch Lake for make-up water would occur when new water can be added to the system which occurs only when the first five sources of water cannot meet the demand).

As a part of the water management strategy, make-up water from Birch Lake, and contact water and industrial stormwater from plant site ponds and tailings management site ponds would have priority uses throughout the underground workings, plant site, and tailings management site, which would be fulfilled before the water would be routed to the process water pond. These priority water uses include, but are not limited to:

- Tailings filter cloth wash;
- Reagent make-up;
- Pump gland water; and
- Mine supply water.

Priority uses would draw water directly from the flow from Birch Lake or from a plant site pond or tailings management site pond when available, before that water was routed to the process water pond. Flows to priority uses are not detailed in the section *Process Water Management* and the section *Contact Water Management.* These sections simplify some aspects of process water management by saying that all make-up water from Birch Lake, all contact water from plant site pond 2 and tailings management site pond 1, and industrial stormwater from plant site ponds 1 and 3 and tailings management site ponds 2 through 5 would be routed to the process water pond, and that all process water demands, including priority uses, would be fulfilled from the process water pond. This simplification is accurate in terms of the water balance and the ultimate water destination.

Process water sources would be:

- Return water from the concentrator as a result of thickening and filtering the concentrates;
- Return water from the tailings dewatering plant as a result of thickening and filtering the tailings;
- Direct precipitation on the process water pond;
- Mixed water from the underground mine and tailings management site;
- Contact water from the plant site;
- Contact water from the tailings management site;
- Industrial stormwater; and
- Make-up water from Birch Lake.

Process water losses would be:

- Water consumed in the engineered tailings backfill;
- Residual water in the filtered tailings placed on the dry stack facility;
- Residual water in the concentrate products;
- Evaporation from the concentrator;
- Evaporation from the underground mine (ventilation losses)
- Evaporation from the process water pond, sediment pond, and tailings management site pond 1; and
- Evaporation from the dry stack facility

The following sections describe process water management at the underground mine, plant site, and tailings management site.

Underground Mine Process Water Management

Process water associated with the engineered tailings backfill would come from two sources. First, after the engineered tailings backfill has settled and solidified, excess process water (engineered tailings backfill bleed water) would report to sumps. Second, engineered tailings backfill lines would be flushed with process water and this would report to the sumps.

This process water would mix underground with other sources of underground mine water. Underground mine water would be classified as mixed water, as described in the section *Contact Water Management*.

Plant Site Process Water Management

Process water at the plant site would circulate between the process water pond and the concentrator. Flows of recycled mixed water from the underground workings would be routed to the sediment pond before it would report to the process water pond. Flows of recycled process water from the tailings management site and of mixed water, contact water, and industrial stormwater from the plant site and the tailings management site would be routed to the process water pond at the plant site.

The process water pond would be the central collection and distribution point for process water used during ore processing. It would also supply service water to the underground workings. The location of the process water pond is shown on Figure 3-10.

The process water pond would be a double-lined pond with leak detection designed for year-round operation with a volume of 18.5 million gal (70,000 m^3). The process water pond would not function as a collection point for contact water or industrial stormwater at the plant site (plant site pond 2 would collect contact water and plant site ponds 1 and 3 would collect industrial stormwater and pump it to the process water pond), therefore the process water pond would be designed with appropriate freeboard to contain the 72-hour probable maximum precipitation from direct precipitation for the process water pond footprint. The process water pond liner system would consist of a 60 mil (1.5 mm) high-density polyethylene (HDPE) or engineer-approved alternate geomembrane liner underlain by a geocomposite drainage layer, a 40 mil (1.0 mm) HDPE or engineer-approved alternate geomembrane liner, and a 1-foot (30.5-centimeters [cm]) layer of compacted material. A process water tank would be installed to act as a buffer between the process water pond and the concentrator; a make-up tank would be installed to act as a distribution point for make-up water from Birch Lake.

<u>Tailings Management Site Process Water Management</u>

At the tailings management site, process water would be managed within the tailings dewatering plant. At the tailings dewatering plant, process water would flow from the concentrator to the tailings dewatering plant with the tailings. Process water would be removed from the solids during the thickening and filtering processes within the tailings dewatering plant and this process water would be recirculated to the process water pond for reuse in the process. Process water would be used to transport the engineered tailings backfill underground for placement. Process water would remain in the tailings filter cake that is transported by truck to the dry stack facility for permanent placement.

The dry stack facility would be constructed as a compacted fill slope with no internal pond. The filtered tailings would be unsaturated after placement and compaction although there would be entrained process water in the void space of the tailings. The potential for draining of the entrained process water by gravity over time is expected to be minimal and requires additional study. Any draining of entrained process water would mix with infiltrating precipitation and be collected by the dry stack facility liner system referred to as draindown; draindown would be classified as mixed water and managed as contact water, as described in the section *Contact Water Management*.

Contact Water Management

Footprints managed as contact water areas would be graded to direct stormwater to contact water ponds for storage before use in the process. There would be contact water areas at the underground mine, plant site, and tailings management site. There would be no contact water areas associated with the ventilation raise sites or the three corridors: access road corridor, water intake corridor, and transmission corridor.

Underground Mine Contact Water Management

The underground workings would have one mine dewatering system and the water would be classified as mixed water and managed as contact water. While individual sources of underground mine water could initially be classified as contact water, mixing with process water could occur underground, thus all underground mine water would be classified as mixed water.

Underground mine water would report to dewatering sumps, including water from the following sources:

- Mine inflow (groundwater that flows into the underground workings);
- Process water associated with the engineered tailings backfill (described in section Underground Mine Process Water Management); and
- Mine supply water.

Mine supply water for the underground mine would flow from the mine water tank to the portals to feed the underground mine-wide supply water distribution system. The mine water tank would be supplied from the fresh/fire water tanks, when new water can be added to the system, otherwise the mine water tank would be fed by the sediment pond. Mine supply water would be used for dust suppression and equipment requirements like drill water. Excess mine supply water would be recaptured through a series of sumps.

The dewatering system would consist of collection sumps, face pumps, skid pumps, tank pumping stations, secondary and primary pump stations, and main pump stations. The pumps would report to the main pump station and the underground mine water would be pumped through the conveyor decline to the sediment pond at the plant site. Underground mine water would need to be cleared of sediment as well as de-oiled before it could be re-used as mine supply water or as process water. This would occur at the sediment pond before recirculating back underground through the mine water supply system or added to the process water circuit for use in processing.

Evaporation of water underground would occur from wetted down material and sumps. The evaporation underground would exit the mine as moisture in the mine ventilation exhaust.

Plant Site Contact Water Management

The plant site would be divided into industrial stormwater areas and contact water areas. The contact water areas at the plant site would be associated with the temporary rock storage facility. The contact water area of the plant site would be graded to collect stormwater into plant site pond 2. The sediment pond would receive underground mine water, which would be classified as mixed water and managed as contact water. The sediment pond and plant site pond 2 are shown on Figure 3-10.

Sediment Pond

Underground mine water would be pumped to the sediment pond to be de-oiled and clarified. Outflow from the sediment pond would report to the process water pond.

The sediment pond would be a 60 thousandth of an inch (mil) HPDE or engineer-approved alternate geomembrane liner over a 1 ft (300 mm) thick, low-permeability, compacted soil liner and would be sized to require clean-out less than once a year.

Plant Site Pond 2

Plant site pond 2 would be sized to contain a 100-year, 24-hour storm event. Plant site pond 2 would be lined with a 60 mil HPDE or engineer-approved alternate geomembrane liner over a 1-ft (300-mm) thick, low-permeability, compacted soil liner; the soil layer would be compacted to meet maximum hydraulic conductivity requirements of not more than 1 x 10^{-6} centimeters per second (cm/sec). The catchment area for plant site pond 2 would include the temporary rock storage facility. Contact water collected in plant site pond 2 would be pumped into the process water pond and used as process water. Plant site pond 2 would be normally kept at a minimal level and water would be pumped to the process water pond. If the process water pond is at risk of exceeding a maximum operational volume threshold based on freeboard requirements, excess water would be directed to the process circuit where it would be included in the tailings stream sent to the tailings dewatering plant.

The temporary rock storage facility would be lined with an 80 mil (2.0 mm) linear low-density polyethylene (LLDPE) or engineer-approved alternate geomembrane liner. The LLDPE liner would be installed over 12 inches (300 mm) of compacted low permeability soil. The liner would be protected by 12 inches (300 mm) of sand which would be pushed into place by dozers and compacted prior to any truck traffic being allowed over the liner. All contact water from the temporary rock storage facility would be collected in a perimeter ditch designed for a 10-year storm event and conveyed to plant site pond 2. The coarse gradation of the material placed on the temporary rock storage facility would provide good drainage to limit build-up of pore-pressure. The rock and underlying sand protection layer would have a sufficiently high permeability to drain towards the perimeter ditches. After material has been processed, the temporary rock storage facility would be reclaimed and would be replaced by the much smaller secondary ore stockpile. Contact water from the secondary ore stockpile would also be collected in the perimeter ditch and conveyed to plant site pond 2.

Snowmelt from the temporary rock storage facility would also be managed as contact water. Grading of the contact water area at the plant site would ensure snow-related runoff would flow into plant site pond 2.

Tailings Management Site Contact Water Management

Water managed as contact water at the tailings management site would consist of:

- Water collected by the dry stack facility's over-liner drains, which would consist of precipitation that has infiltrated through the tailings (contact water) mixed with residual process water that has drained from within the tailings (referred to as draindown, classified as mixed water, and managed as contact water);
- Water collected by the dry stack facility's under-liner drains; and
- Precipitation and runoff within the catchment area of the dry stack facility perimeter ditch, which would begin at the downslope edge of the dry stack facility runoff collection ditch and extend to the perimeter haul road.

The dry stack facility contact water management system would include a liner system (including over-liner and under-liner drains), dry stack facility perimeter ditch, groundwater cutoff wall, and tailings management site pond 1. Contact water would be collected and routed via the dry stack facility perimeter ditch to tailings management site pond 1. In upset conditions, excess process water at the tailings dewatering plant could also be routed to tailings management site pond 1. Water collected in tailings management site pond 1 would be pumped to the process water pond at the plant site for use as process water.

Until the dry stack facility is covered during concurrent reclamation, some of the precipitation that falls on the tailings may infiltrate and percolate vertically through the tailings. Infiltrating precipitation would be intercepted by the dry stack facility liner system. The liner system includes an over-liner drain, a geomembrane liner, and an under-liner drain; a typical cross section of the liner system is shown in Figure 3-18.

The first step in construction of the liner system would be to install a network of gravel under-liner drains along the natural drainage courses (i.e., low points in the topography to which water would naturally drain) that cross the dry stack facility footprint. The gravel drains would be created by excavating ditches into the foundation soils at the base of these drainage courses. The excavated ditches would be backfilled with gravel. The under-liner drain would discharge to the dry stack facility perimeter ditch. The purpose of the under-liner drains would be to limit the phreatic head in the foundation soils under the geomembrane liner to prevent uplift of the liner prior to tailings placement. The under-liner drain would also be a secondary control to capture potential seepage through the dry stack facility liner. Seepage through the membrane to the under-liner drain is expected to be insignificant due the design of the dry stack facility, QA/QC during construction, and documented performance of other dry stack facilities; however, quantity and quality of seepage has not been calculated and will be addressed as a future scope of work. Seepage from the dry stack facility would be further controlled by the construction of the groundwater cutoff wall. The potential magnitude of seepage has not yet been quantified and would be addressed as a future scope of work, as discussed in Section 6.3.2.

The dry stack facility geomembrane liner would be a 60 mil (1.5 mm) thick LLDPE or engineer-approved alternate geomembrane liner. The LLDPE liner would be installed over the prepared foundation and over the network of gravel under-liner drains. The liner would be protected by a minimum 1 ft (0.3 m) thick layer of compacted tailings on top of the liner which would be, pushed into place by dozers and compacted prior to any haul truck traffic being allowed over the liner.

The intercepted precipitation that would infiltrate through the tailings – referred to as draindown – would be intercepted by the liner and collected by a network of gravel finger drains constructed above the liner extending across the dry stack facility footprint in the same location as the under-liner drains (i.e., natural drainage courses). A gravel blanket drain would also be constructed around the full perimeter of the dry stack facility at the toe, having a width of 160 ft (50 m). The over-liner drains - both finger drains and blanket toe drain - would discharge to the dry stack facility perimeter ditch. The potential magnitude of draindown has not yet been quantified and would be addressed as a future scope of work, as discussed in Section 6.3.2.

The dry stack facility perimeter ditch would route contact water to tailings management site pond 1. For significant portions of its length, the dry stack facility perimeter ditch would be excavated into bedrock. The dry stack facility perimeter ditch would be sized for the peak flow from a 100-year, 24-hour rainfall event. The dry stack facility perimeter ditch side slopes and base of the ditch would be a compacted low permeability soil. In locations where the ditches would be excavated into soil, the side slopes and base of the ditch would be protected against erosion with grass vegetation or armoring with riprap or alternate permanent erosion control measures.

The catchment area for the dry stack facility perimeter ditch begins at the downslope edge of the dry stack facility runoff collection ditch and extends to the perimeter haul road. The groundwater cutoff wall would be on the outer edge of the dry stack facility perimeter ditch beneath the perimeter haul road to encompass the dry stack facility and dry stack facility perimeter ditch. The perimeter haul road would be graded to drain to the dry stack facility perimeter ditch. The groundwater cutoff wall would include a seepage cutoff trench with a grout curtain installed as necessary depending on bedrock condition. The seepage cutoff trench would consist of an excavated trench from ground surface to the top of bedrock that would be backfilled with compacted, low permeability soil. In locations where the bedrock has been identified as fractured, faulted, or weathered, a grout curtain would be installed, consisting of pressure grouted boreholes to a depth that would be based on geotechnical investigations. The groundwater cutoff wall would serve two purposes: 1) reduce flow of regional groundwater from outside the dry stack facility footprint into the foundation soils below the dry stack facility, minimizing the need to manage additional non-contact water volumes and 2) restrict the flow of contact water out of the dry stack facility perimeter ditch and dry stack facility. Figure 3-19 shows a typical cross section of the exterior slope of the dry stack facility, including the

Figure 3-20 shows a typical dry stack facility perimeter ditch and includes more detail on the dry stack facility perimeter ditch, groundwater cutoff wall, and the perimeter gravel road.

One tailings management site contact water pond (tailings management site pond 1) would be constructed, as shown on Figure 3-13. Tailings management site pond 1 would be sized to contain the 100-year, 24-hour storm event for its catchment area. Tailings management site pond 1 would be single lined with the same liner design as plant site pond 2.

The dry stack facility contact water management system (liner, over-liner and under-liner drains, dry stack facility perimeter ditch, groundwater cutoff wall, and tailings management site pond 1) would be constructed concurrently with the dry stack facility stages. Stage 1 of the dry stack facility would include construction of tailings management site pond 1.

The dry stack facility would be concurrently reclaimed during the operation phase. As portions of the slope and crest of the dry stack facility are constructed, the completed surfaces would be graded and covered to promote runoff and inhibit infiltration. The cover would consist of at least 2 ft (.6 m) of cover soil underlain by a hydraulic barrier. The type of hydraulic barrier would be selected based on future design evaluations that would assess compatibility with infiltration design criteria and availability of cover soil materials. Infiltration criteria would be determined based on future tailings geochemistry test work results and permitting requirements. Cover soil would be sourced from the reclamation material stockpile and seeded to establish grasslands.

Industrial Stormwater Management

Industrial stormwater would be managed in the following areas:

- Plant site industrial stormwater areas;
- Tailings management site industrial stormwater areas;
- Underground mine area ventilation raise sites; and
- Along the access road and water intake corridors.

Plant Site Industrial Stormwater Management

The plant site would be divided into industrial stormwater areas and contact water areas. The industrial stormwater area at the plant site would include: the mine services buildings, the concentrator, the concentrator services building, explosive magazine, reagent storage building, ball bunker storage, fuel storage area, waste storage area, reclamation material stockpiles 1 and 2, the mine portals, the plant site electrical substation, the internal roads, the areas surrounding and connecting these facilities, and associated snow storage areas. The security gatehouse, bus loop and parking areas, and associated snow storage areas could be managed as non-contact water areas; however, due to proximity to industrial stormwater areas, stormwater from these areas would likely be co-mingled and managed with industrial stormwater.

Managing industrial stormwater areas of the plant site separately from contact water areas would allow flexibility for water management during extreme storm events or significant wet periods. During typical precipitation periods, industrial stormwater collected in plant site pond 1 and plant site pond 3 would be routed to the process water pond as needed for use in the process. However, when the Project has excess water, industrial stormwater at the plant site could be routed through appropriate discharge controls and discharged to the environment in accordance with applicable regulatory requirements and appropriate BMPs.

Plant site pond 1 and plant site pond 3 would be sized to contain a 100-year, 24-hour storm event. Plant site pond 1 and plant site pond 3 would be lined with compacted soil.

Snowmelt from the plant site's industrial stormwater areas would also be managed as industrial stormwater. For snow that is not plowed, snow-related runoff would end up in the same location as if it were runoff from rainfall. For snow plowed in active areas there would be three designated snow storage areas. These snow storage areas have been designed to accommodate a snow water equivalent of between 7.3 to 11.9 inches (185 to 301 mm). Locations of the snow storage areas are shown on Figure 3-10.

During clearing and grubbing, non-saleable lumber would be chipped and used to cover reclamation material stockpile 1 and 2 to prevent wind and water erosion; other sediment control features would be installed as needed. Stormwater from these stockpiles would be managed as industrial stormwater.

Tailings Management Site Industrial Stormwater

The following tailings management site areas would be managed as industrial stormwater areas:

- The surface of exposed dry stack facility tailings prior to reclamation (reclaimed surfaces would be managed as non-contact water areas);
- The tailings dewatering plant area; and
- The tailings management site reclamation material stockpile.

Dry Stack Facility

The dry stack facility would be constructed as a compacted fill slope with no internal pond. Stormwater from the exposed tailings would be shed to the outer edges of the dry stack facility. The dry stack facility crest and slopes would be provided with swales, ditches, and erosion protection in the ditches to prevent formation of gullies and uncontrolled erosion. The dry stack facility swales and ditches that direct water off the dry stack facility would discharge into the dry stack facility runoff collection ditch that extends around the perimeter of the dry stack facility (inside the perimeter of and upgradient of the dry stack facility perimeter ditch).

Compacting the tailings after placement would increase the amount of runoff and decrease the amount of draindown compared to non-compacted tailings. The crest of the dry stack facility would be graded to shed stormwater to the perimeter of the dry stack facility, limiting ponding of precipitation.

The dry stack facility runoff collection ditch would collect and route dry stack facility runoff to the closest industrial stormwater pond. The dry stack facility runoff collection ditch would be sized for the peak flow from a 100-year, 24-hour rainfall event. The side slopes and base of the ditch would be protected against erosion with grass vegetation or armoring with riprap or alternate permanent erosion control measures.

Four tailings management site industrial stormwater ponds (tailings management site ponds 2 through 5) would be constructed, as shown on Figure 3-13, in addition to two interim industrial stormwater ponds (tailings management site interim ponds 1 and 2) that would be installed to manage water during stage 1 and stage 2 of the dry stack facility before the facility is at the full footprint. The tailings management site interim ponds would be designed and function the same as tailings management site ponds 2 through 5 and are necessary to accomplish the phased staging of the dry stack facility. Tailings management site interim ponds 1 would be located in the allowance for water management features as shown in Figure 3-21. Tailings management site interim ponds 1 and 2 are temporary as tailings would eventually need to be stacked in their locations. Tailings management site ponds 2 through 5 would be sized to contain the 100-year, 24-hour storm event for their respective catchment areas. In addition, the collective storage capacity of the tailings management site ponds for the dry stack facility during operation would be sized to meet the runoff requirements from a 100-year snowpack. Tailings management site ponds 2 through 5 would be lined with compacted soil.

The tailings management site ponds and dry stack facility runoff collection ditches would be constructed concurrently with the dry stack facility stages. Tailings management site interim ponds 1 and 2 would be constructed along the stage 1 and stage 2 interim toes of the dry stack facility. Stage 1 of the dry stack facility would include construction of tailings management site pond 2 and tailings management site interim pond 1. Stage 2 would include construction of tailings management site pond 3 and tailings management site interim pond 2. Stage 3 would include construction of tailings management site pond 4 and tailings management site pond 5.

Industrial stormwater captured in industrial stormwater ponds would be used for dust control at the tailings management site. During typical precipitation periods, industrial stormwater collected in tailings management site ponds would be routed through the contact water collection system to the process water pond as needed for use in the process.

The dry stack facility would be concurrently reclaimed during the operation phase. As portions of the slope and crest of the dry stack facility are constructed, the completed surfaces would be graded and covered to promote runoff and inhibit infiltration. Cover soil would be sourced from the reclamation material stockpile and seeded to establish grasslands. Portions of the dry stack facility that have been concurrently reclaimed would no longer be industrial areas, thus runoff would no longer be industrial stormwater; runoff from reclaimed areas would be collected in the dry stack facility runoff collection ditch, which once the slope was reclaimed, would be converted to manage non-contact water, as described in section Non-contact Water Management.

Tailings Dewatering Plant

The tailings dewatering plant would be managed as an industrial stormwater area to allow flexibility for water management during extreme storm events. Industrial stormwater at the tailings dewatering plant would be routed through a culvert to tailings dewatering plant pond 1, located within the traffic circle east of the filter cake storage and loadout building. During typical precipitation periods, industrial stormwater from tailings dewatering plant pond 1 would then be routed to the dry stack facility perimeter ditch and combined with the mixed water conveyed to tailings management site pond 1. However, during extreme storm events or significant wet periods when the Project has excess water, industrial stormwater from tailings dewatering plant pond 1 could be routed through appropriate discharge controls and discharged to the environment in accordance with applicable regulatory requirements and appropriate BMPs.

Tailings Management Site Reclamation Material Stockpile

Stormwater from the tailings management site reclamation material stockpile would be captured in perimeter ditches that would discharge into the reclamation material stockpile sedimentation pond. The outlet from the tailings management site reclamation material stockpile sedimentation pond would be to the north, with an ultimate outlet through the non-contact water ditch to the west. Erosion of the reclamation material stockpile would be limited through seeding of the stockpile surface with grass and temporary erosion control measures (e.g., silt fencing) until the vegetation is established.

<u>Underground Mine Area Ventilation Raise Sites Industrial Stormwater Management</u>

Stormwater from the ventilation raise sites and the ventilation raise access road would be managed as industrial stormwater. Industrial stormwater from these areas would be directed to the environment and would be managed to meet applicable regulatory requirements. BMPs would be implemented to meet erosion control and stormwater management requirements.

<u>Access Road and Water Intake Corridors Industrial Stormwater Management</u>

Direct precipitation and stormwater would generate industrial stormwater along the access road corridor and water intake corridor. Industrial stormwater from these areas would be directed to the environment and would be managed to meet applicable regulatory requirements. BMPs would be implemented as needed to meet erosion control and stormwater management requirements.

Non-contact Water Management

Non-contact water would be managed in the following areas:

- Non-contact water diversion area;

- Plant site non-contact water area;
- Tailings management site non-contact water areas; and
- Along the transmission corridors.

BMPs would be used as needed across the Project to manage non-contact water. BMPs may include, but are not limited to, mulching and biodegradable erosion control blankets, establishing and maintaining vegetation, collection and conveyance structures (e.g., swales, ditches, and culverts), non-vegetative soil stabilization such as rock armoring, and sediment barriers or basins.

Non-contact Water Diversion Area Water Management

Non-contact water from the adjacent watersheds would be intercepted and diverted around the plant site and the tailings management site to prevent non-contact water from co-mingling with contact water and to protect infrastructure.

To divert non-contact water around the plant site, two non-contact water ditches, would be constructed to intercept and divert water south of the plant site. To divert non-contact water around the tailings management site, non-contact water ditches and diversion dikes would be constructed in stages, corresponding to the staged development of the dry stack facility. Interception and diversion of non-contact water from adjacent wetlands and watersheds would be managed through non-contact water ditches and diversion dikes, as shown on Figure 3-13.

The five diversion dikes around the north side of the tailings management site would be offset at least 328 ft (100 m) from the outer edge of the perimeter haul road. These diversion dikes would be staged concurrently with the dry stack facility construction stages. They would be constructed by placing and compacting fill across drainage depressions, as required, and armoring the upstream side with riprap. These dikes would result in ponding of non-contact water from adjacent surface flows. The non-contact water ponds would not be constructed ponds. On Figure 3-13 they are shown as the size pond that would form from a 100-year, 24-hour storm event. Four non-contact water ditches would be built to drain ponded water from the diversion dikes on the north side of the tailings management site to Birch Lake.

The three diversion dikes and a non-contact water ditch on the northeast side of the tailings management site would intercept and divert water east. Water impounded on the east side of the most eastern diversion dike would eventually overtop a “saddle” and flow out of the drainage course into a tributary of Keeley Creek.

The diversion dikes would be designed to hold back the runoff from a 100-year, 24hour storm event while maintaining a minimum 3.3 ft (1 m) of freeboard. The non-contact water ditches would be designed to convey the peak flow from a 10-year, 24-hour storm event with no erosion. The non-contact water ditches would be designed to convey the 100-year, 24-hour storm event with a minimum freeboard of 1 ft (0.3 m). The diversion ditches would be designed with the appropriate slope to control for suspended sediment. The non-contact water ditches would discharge to existing drainage ways or other diversions ditches through energy dissipation devices (e.g., rip-rap, erosion control mats, etc.). Non-contact water ditches would be maintained throughout concurrent reclamation activities and would be integrated into drainage features at the tailings management site during the closure stage of the Project.

Plant Site Non-contact Water Management

The exterior working pad edges and side-slopes at the plant site would be a non-contact water area. These slopes would be vegetated and designed to limit erosion. Non-contact water from the slopes would be routed through appropriate discharge controls (as needed).

Tailings Management Site Non-contact Water Management

The tailings management site would manage the following four main non-contact areas:

- Undeveloped portions of the tailings management site prior to development of stage 2 and 3;
- Portion of the exposed dry stack facility liner prior to tailings placement;
- Outer embankment of the tailings management site; and
- Reclaimed portion of the dry stack facility.

Undeveloped Portion of the Tailings Management Site

Prior to development of dry stack facility stage 2 and stage 3, the footprint of stage 2 and stage 3 would be undeveloped. Stormwater on the undeveloped land would be non-contact water and continue to flow around the dry stack facility footprint unaffected by the development of the dry stack facility at that point in time. The footprint of dry stack facility stage 2 and 3 would be non-contact water during operations when tailings are placed on stage 1. The footprint of dry stack facility stage 2 would be managed as non-contact water during operations when tailings are placed on stage 3.

Exposed Dry Stack Facility Liner

Prior to development of each stage of the dry stack facility, the liner would be installed over the entire footprint of that stage, an area of approximately 120 to 160 acres. Tailings filter cake would be placed and compacted gradually from west to east across the lined area, with a portion of the liner remaining exposed until the stage is complete. To minimize the volume of mixed water and industrial stormwater, TMM would manage portions of the exposed dry stack facility liner as non-contact areas. TMM would prevent runoff (industrial stormwater) and draindown (mixed water) from the dry stack from flowing onto the non-contact areas of the exposed liner by using a temporary system of berms, piping, and pumps as necessary to route mixed water to the dry stack facility perimeter ditch and industrial stormwater to the dry stack facility runoff collection ditch. The temporary water management infrastructure separating the contact water, industrial stormwater, and non-contact water areas of the exposed liner would be periodically adjusted as tailings placement progresses eastward.

Outer Embankment of the Tailings Management Site

The outer embankment of the tailings management site, including the exterior side-slopes of perimeter haul roads, would be managed as non-contact areas. These slopes would be vegetated and designed to limit erosion. Non-contact water from the slopes would be routed to the environment through appropriate discharge controls (as needed).

Reclaimed Portion of the Dry Stack Facility

During concurrent reclamation of the dry stack facility, a cover system would be installed. The final dry stack facility cover system would consist of a cover soil underlain by a hydraulic barrier. The cover system would be designed to function as a growth medium to support revegetation, reclassify the covered area of the dry stack facility as a non-contact water area and acting as a hydraulic barrier to mitigate the generation of draindown and / or seepage in closure.

Tailings filter cake would be preferentially placed to promote runoff and inhibit infiltration as part of operations and likely relatively little grading would be required to establish a finished slope towards the perimeter of the dry stack facility. The contouring of the dry stack facility surface for reclamation and placement of cover material would be continued in a manner that promotes runoff and inhibits infiltration.

The dry stack facility would be constructed in three stages, generally starting on the west side of the dry stack facility nearest the tailings dewatering plant, and progressing eastward during the life of the Project. The dry stack facility would correspondingly be constructed by placing, grading, and compacting tailings to form lifts and benches on as described in the Tailings Management Site section. The exterior side slope of the dry stack facility would be reclaimed concurrent with their construction and BMPs, such as silt fences, erosion control mats and / or logs, and temporary mulch erosion controls, placed until vegetation became established.

Portions of the dry stack facility that have been concurrently reclaimed would no longer be industrial areas, thus runoff would no longer be industrial stormwater and would instead be managed as non-contact water. In these areas, runoff would be collected in the dry stack facility runoff collection ditch, which once the slope was reclaimed, would be converted to manage non-contact water as shown in Figure 3-20. These temporary dry stack facility runoff collection ditches would have the same design and function as the other dry stack facility runoff collection ditches and would drain to controls to remove suspended solids. Controls for suspended solids removal may include but are not limited to temporary dedicated settling / detention ponds or other controls and would drain to the surrounding environment following removal of suspended solids.

The post-closure surface of the dry stack facility would be graded to drain toward the perimeter of the dry stack facility. Reclamation design would aim to create conditions where runoff rates and volumes are similar to runoff reaching downstream surface water receptors for pre-Project site conditions. When the dry stack facility surface is fully revegetated and vegetation growth is dense and well established, runoff may no longer require suspended solids removal to meet water quality standards. Once suspended solids removal is no longer necessary, runoff would be discharged directly to the environment and the collection ditches and ponds (both contact and non-contact) would be reclaimed and revegetated.

Transmission Corridor Non-contact Water Management

Direct precipitation and stormwater would generate non-contact water along the transmission corridor. Non-contact water from these areas would be directed to the environment. BMPs would be implemented as needed to minimize erosion.

Construction Stormwater and Construction Dewatering Water Management

Construction activities would be conducted in accordance with the Minnesota Construction Stormwater General Permit, following standard BMPs. Specific BMPs would likely include:

- Erosion and sediment control structures such as diversions (e.g., stormwater interceptor trenches, check dams, or swales), siltation or filter berms, filter or silt fences, filter strips, sediment barriers, and / or sediment basins;
- Collection and conveyance structures, such as rock lined ditches and / or swales;
- Vegetative soil stabilization practices such as seeding, mulching, and / or brush layering and matting;
- Non-vegetative soil stabilization practices such as rock and gravel mulches, jute and / or synthetic netting;
- Slope stabilization practices such as slope shaping, and the use of retaining structures and riprap; and
- Infiltration systems such as infiltration trenches and / or basins.

Following construction activities, areas such as cut and fill slopes, embankments, and reclamation material stockpile would be seeded as soon as practicable. Construction stormwater and construction dewatering water would be discharged, as required, in compliance with permits.

Concurrent reclamation would be maximized to the extent practicable to accelerate revegetation of disturbed areas. Sediment and erosion control BMPs would be routinely inspected, evaluated for performance, and maintenance and repairs performed, as needed. BMPs such as straw wattles or staked straw bales would be used as necessary to contain sediment liberated from direct precipitation. BMPs such as sediment basins and filter bags would be used to remove sediment from construction dewatering water prior to discharge.

Water Management at Closure

Closure and reclamation of the plant site and tailings dewatering plant would include use of surface water management features to control erosion, and stormwater quality, quantity, and rates. Once the planned plant site post-closure surface topography is established, reclamation cover materials, serving as a growth medium for revegetation, would be placed. The post-closure surface of the plant site would be graded with the goal to re-establish pre-mining hydrology, which generally would allow the site to drain toward adjacent wetland complexes.

During the closure stage of the dry stack facility, the dry stack facility cover system would mitigate the generation of dry stack facility draindown and seepage. If draindown and / or seepage occurred and did not meet water quality requirements, and if planned management methods are no longer available, treatment technologies and management options would be evaluated to identify methods to meet water quality standards. If draindown and / or seepage did occur and was shown by monitoring to meet surface water quality requirements, it would be routed to dry stack facility runoff collection ditches.

3.6.2.12 Environmental Protection Measures

The following general considerations, commitments, and design criteria have been applied to the Project for the purpose of protecting environmental resources:

- The Project has been designed as an underground mine to reduce surface disturbance, noise, fugitive dust, light emissions, and visual and surface water-related impacts;
- No mining would occur under Birch Lake;
- The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water;
- The Project’s ore processing circuit has been designed to remove sulfide minerals. Thus, tailings from the Project would not produce ARD;
- No waste rock would be permanently stored on the surface thereby eliminating a potential source of ARD;
- A dry stack facility has been selected as a tailings management method to reduce ground disturbance, wetland impacts, water appropriation requirements, and the potential for seepage. Additionally, a dry stack facility has been selected because it would be highly geotechnically stable; and
- After Project closure the only permanent infrastructure that would remain would be the dry stack facility and some non-contact water management features.

The following considerations, commitments, and design criteria have been applied to the Project for the purpose of protecting specific environmental resources:

- To protect water resources:
    - The process water pond would be double-lined with leak detection as described in the section *Water Management Plan*;
    - All contact water ponds would be single lined over low-permeability compacted soil layer as described in the section *Water Management Plan*;
    - Contact water ponds and industrial stormwater ponds would be sized to contain a 100-year, 24-hour storm event. In addition, the collective storage capacity of the tailings management site ponds for the dry

stack facility would be sized to meet the runoff requirements from a 100-year snowpack;
    - The dry stack facility would be lined as described in the section *Water Management Plan*;
    - The dry stack facility would include over-liner drains and a blanket toe drain to capture draindown intercepted by the liner at the base of the dry stack facility;
    - The dry stack facility would include an under-liner drainage system to protect groundwater resources if seepage occurs. The under-liner drainage system would be designed to capture seepage and route it to the dry stack facility perimeter ditch;
    - A cover would be placed on the dry stack facility, as described in the section *Water Management Plan*;
    - Groundwater cutoff wall would be installed during construction of the dry stack facility to protect water resources in the event the dry stack facility produces seepage;
    - The dry stack facility design and location has been optimized to avoid direct impacts to Keeley Creek;
    - Pipes containing petroleum products, liquid reagents, or processing fluids would be double-walled and/or would have a system of leak detection and secondary containment, as necessary; and
    - Reclamation material stockpiles would be covered with wood chips and revegetated to prevent erosion.

- To protect wetland resources:

    - Project infrastructure has been designed and located to avoid wetlands; and
    - The dry stack facility design and location has been optimized to avoid direct impacts to adjacent wetlands.

- To protect cultural resources:

    - The Project area has been sited and designed to avoid or minimize impacts to cultural resources; and
    - The access road has been sited and designed to avoid a known cultural resource.

- To reduce impacts from noise:

    - The concentrator building and water intake facility have been designed to be higher grade buildings with a Sound Transmission Class suitable to prevent potential impacts from noise;
    - For the concentrator building and water intake facility, primary ventilation openings would be equipped with standard acoustical louvers;
    - Exhaust outlets on building would be equipped with silencers;
    - The crushers would be located underground;
    - The exhaust ventilation fans for the underground mine would be located underground; and

  - Above-ground conveyor transfer points would be equipped with sound barriers, as needed.

- To reduce impacts to air quality:
  - The primary ore stockpile would be covered;
  - Conveyors would be covered and water sprays would be provided at transfer points, as needed, to control dust;
  - The crushers would be located underground to reduce dust;
  - Most employees would be transported via bus to the Project from the administration building in Babbitt or the parking lot in Ely to reduce traffic and associated emissions;
  - To reduce dust, concentrate would be loaded into sealed containers within a building prior to being transported off-site; and
  - Instead of constructing in-situ power production facilities, a transmission line would be extended from an off-site electrical substation to provide power to the Project.

- To protect visual resources, the potential for visibility of mine structures or activities from high intensity recreation areas has been reduced:
  - The primary ore stockpile has been designed to minimize the height of its geodesic dome cover;
  - The comminution circuit and the flotation circuit have been specifically designed to reduce the height of the concentrator building;
  - The mine would be accessed via a decline rather than a shaft, thus eliminating the need for a tall headframe;
  - The dry stack facility would be concurrently reclaimed, whereby construction and revegetation would be sequenced to minimize potential effects to the view from Birch Lake;
  - Building colors would be selected to blend into the surrounding environment; and
  - Steps would be taken to limit light visibility consistent with the International Dark Sky Association.

- To reduce impacts related to surface disturbance:
  - The underground workings would be backfilled with waste rock and engineered tailings backfill to reduce surface disturbance;
  - Vent raises would be located on or near existing USFS and exploration drill roads to reduce surface disturbance from new roads;
  - Exhaust vent fans would be located underground;
  - Power for the surface ventilation raises would be brought up from the underground workings to minimize surface disturbance associated with transformers and power distribution lines; and
  - Concentrate would be trucked from the plant site to existing port facilities to reduce additional surface disturbance associated with rail-loadout areas;

- To prevent subsidence, the Project would operate with an appropriate crown pillar depth.

3.6.3 Project Magnitude

Please see Table 3-1 Project Magnitude for Project Surface Disturbance and Table 3-5 through Table 3-8 for Project infrastructure dimensions.

Table 3-5 Plant Site Building Square Footages

Property	Building Type	Commercial Building Area (sq ft)[1]	Industrial Building Area (sq ft)[2]	Building Height (ft)[3]	Notes
Concentrator Building[4]	Pre-Engineered	0	132700	66	Buildings are all attached
Grinding Mill Area	Pre-Engineered	0	35000	66	Part of main concentrator building
Flotation and Dewatering Area	Pre-Engineered	0	67000	66	Part of main concentrator building
Concentrate Storage and Loadout Area	Pre-Engineered	0	16000	38	Lean-to off concentrator building
Reagent Makeup Area	Pre-Engineered	0	7800	44	Lean-to off concentrator building
Air Services Area	Pre-Engineered	0	6900	44	Lean-to off concentrator building
Primary Ore Stockpiling Building	Geodesic Dome	0	35000	94	Dome
Mine Services Building	Pre-Engineered	15000	38000	39	2 stories for a portion of the building
Concentrator Services Building	Pre-Engineered	11000	17000	26	2 stories for a portion of the building
Reagent Storage	Fabric Building	0	7000	26	None
Ball Storage Bunker	Fabric Building	0	3600	26	None
Security Building / Gatehouse	Modular Building	0	340	10	None
Water Intake Facility Building	Modular Building	0	320	15	None
Tire Wash Building	Modular Building	0	3600	26	None

Notes:
[1] Commercial building areas are workplaces, offices, and locker rooms, that support the operation.
[2] Industrial building areas are factory or warehouse buildings, where product is made or stored.
[3] Building heights are inclusive of any associated vertical stacks
[4] Concentrator is composed of grinding mill area, flotation and dewatering area, concentrate storage and loadout area, reagent makeup area, and air services area

Abbreviations:
ft = feet
sq ft = square feet

Table 3-6 Tailings Management Building Square Footages

Property	Building Type	Commercial Building Area (sq ft)[1]	Industrial Building Area (sq ft)[2]	Building Height (ft)[3]	Notes
Tailings Filter Plant	Pre-Engineered	0	42000	115	None
Backfill Plant	Pre-Engineered	0	5400	31	None
Filter Cake Storage and Loadout Building	Pre-Engineered	0	47500	59	None

Notes:
[1] Commercial building areas are workplaces, offices, and locker rooms, that support the operation.
[2] Industrial building areas are factory or warehouse buildings, where product is made or stored.
[3] Building heights are inclusive of any associated vertical stacks
Abbreviations:
ft = feet
sq ft = square feet

Table 3-7 Off-Site Building Square Footage

Property	Building Type	Commercial Building Area (sq ft)[1]	Industrial Building Area (sq ft)[2]	Building Height (ft)[3]	Notes
Administration Building (Babbitt)	Pre-Engineered	7800	0	16	None

Notes:
[1] Commercial building areas are workplaces, offices, and locker rooms, that support the operation.
[2] Industrial building areas are factory or warehouse buildings, where product is made or stored.
[3] Building heights are inclusive of any associated vertical stacks
Abbreviations:
ft = feet
sq ft = square feet

Table 3-8 Temporary Rock Storage Facility Design Parameters and Dimensions Summary

Inter-Bench Slope (Gradient)	Overall Slope (Gradient)	Lift Height (ft / m)	Max Height Above Original Topo (ft / m)	Crest Elevation (ft amsl)	Surface Area (acres)	Volume
1.3H:1V (38°)	1.8H:1V (29°)	40 / 12	85 / 6	1540	11	722,000 yd3 / 1,213,000 short ton / 1,100,415 ton

3.6.4 Project Purpose

The purpose of the Project is to mine the Maturi deposit by underground methods to produce concentrates for base, platinum group, and other metals.

3.6.5 Future Stages

Are future stages of this development including development on any other property planned or likely to happen? ☐ Yes ☒ No

The Project is based on the Maturi deposit alone and is independent of any other future activity. There are currently no other projects, stages, or developments associated with the Project. It would be speculative at best to anticipate a future project given the long planning horizon for metallic mining projects and any future project would need to undergo separate environmental review at that time.

3.6.6 Earlier Project Stage

Is this Project a subsequent stage of an earlier project? ☐ Yes ☒ No

3.7 Cover Types

Table 3-9 through Table 3-17 provides estimated areas by land cover types as identified in the National Land Cover Database (NLCD) for the Project area and the areas with potential ground disturbance, including the ventilation raise sites, ventilation access road, plant site, tailings management site, access road, water intake corridor, and transmission corridor. During the construction and operation phases these land covers would be converted to accommodate the Project facilities. Reclamation plans, as outlined in Section 3.6.2, are designed to restore, to the degree practicable, these areas to previous land cover types.

Table 3-9 Project Area Land Cover

Title	Before	Operations	After[1]
Wetlands	2695.2	2295.1	2309.0
Deep water/streams	63.6	55.7	55.7
Wooded/forest	3479.8	2801.8	2995.3
Brush/Grassland	3.3	612.8	842.9
Cropland	1.4	1.4	1.4
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	45.1	306.8	84.1
Stormwater Pond	0.0	74.3	0.0
Other (describe)	0.0	140.5	0.0
TOTAL	6288.4	6288.4	6288.4

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-10 Project Land Cover

Title	Before	Operations	After[1]
Wetlands	431.2	31.1	45.0
Deep water/streams	8.2	0.3	0.3
Wooded/forest	711.0	33.0	226.5
Brush/Grassland	0.4	609.9	840.0
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	4.6	266.3	43.6
Stormwater Pond	0.0	74.3	0.0
Other (describe)	0.0	140.5	0.0
TOTAL	1155.4	1155.4	1155.4

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-11 Plant Site Land Cover

Title	Before	Operations	After[1]
Wetlands	48.5	0.0	0.0
Deep water/streams	0.4	0.0	0.0
Wooded/forest	103.8	0.0	152.9
Brush/Grassland	0.2	0.0	0.0
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	0.0	152.9	0.0
Stormwater Pond	0.0	0.0	0.0
Other (describe)	0.0	0.0	0.0
TOTAL	152.9	152.9	152.9

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-12 TMS Land Cover

Title	Before	Operations	After[1]
Wetlands	275.4	0.0	0.0
Deep water/streams	5.3	0.0	0.0
Wooded/forest	370.9	0.0	0.0
Brush/Grassland	0.2	438.4	653.1
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	1.3	32.1	0.0
Stormwater Pond	0.0	45.0	0.0
Other (describe)	0.0	137.6	0.0
TOTAL	653.1	653.1	653.1

Notes

Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.

[1] Acreages calculated for operations at the end of stage 3 of the dry stack facility construction and represent the maximum extent.

[2] Other counts the approximately 120 acres of dry stack facility stage 3 that hasn't been reclaimed and 16.7 acres of reclamation material stockpile.

[3] Table assumes that dry stack facility stage 1 and stage 2 have been reclaimed as brush/grassland (308 acres) and the rest of the area that is buffered around the Project infrastructure has been cleared and maintained as brush/grassland – likely overstating the actual impacts from the tailing management site to wetlands and wooded/forest land cover.

[3] Stormwater Pond includes ponds and ditches.

[4] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-13 Access Road Land Cover

Title	Before	Operations	After[1]
Wetlands	12.9	0.0	0.0
Deep water/streams	0.0	0.0	0.0
Wooded/forest	30.7	0.0	0.0
Brush/Grassland	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	0.0	43.6	43.6
Stormwater Pond	0.0	0.0	0.0
Other (describe)	0.0	0.0	0.0
TOTAL	43.6	43.6	43.6

Notes

Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.

[1] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-14 Transmission Corridor Land Cover

Title	Before	Operations	After[]
Wetlands	37.0	0.0	0.0
Deep water/streams	2.2	0.0	0.0
Wooded/forest	144.4	0.0	0.0
Brush/Grassland	0.0	171.5	186.9
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	3.3	15.4	0.0
Stormwater Pond	0.0	0.0	0.0
Other (describe)	0.0	0.0	0.0
TOTAL	186.9	186.9	186.9

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Impact to wetlands are likely overstated as there would be opportunities to avoid impacts through siting poles and constructing during frozen conditions.
[2] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-15 Water Intake Corridor / Facility Land Cover

Title	Before	Operations	After[1]
Wetlands	3.2	0.0	0.0
Deep water/streams	0.0	0.0	0.0
Wooded/forest	4.2	0.0	7.4
Brush/Grassland	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	0.0	7.4	0.0
Stormwater Pond	0.0	0.0	0.0
Other (describe)	0.0	0.0	0.0
TOTAL	7.4	7.4	7.4

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-16 Ventilation Raise Sites and Access Road Land Cover

Title	Before	Operations	After[1]
Wetlands	9.2	0.0	0.0
Deep water/streams	0.0	0.0	0.0
Wooded/forest	5.7	0.0	14.9
Brush/Grassland	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	0.0	14.9	0.0
Stormwater Pond	0.0	0.0	0.0
Other (describe)	0.0	0.0	0.0
TOTAL	14.9	14.9	14.9

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

Table 3-17 Non-Contact Water Diversion Area Land Cover

Title	Before	Operations	After[1]
Wetlands	45.0	31.1	45.0
Deep water/streams	0.3	0.3	0.3
Wooded/forest	51.3	33.0	51.3
Brush/Grassland	0.0	0.0	0.0
Cropland	0.0	0.0	0.0
Lawn/landscaping	0.0	0.0	0.0
Impervious surface	0.0	0.0	0.0
Stormwater Pond	0.0	29.3	0.0
Other (describe)	0.0	2.9	0.0
TOTAL	96.6	96.6	96.6

Notes
Land cover was calculated using the USGS GAP/LANDFIRE Data. Wetlands identified in the GAP data may not match with wetlands identified in the NWI survey.
[1] Stormwater Pond includes water ponds and non-contact water ditches.
[2] Other include constructed dikes.
[3] Acreages calculated based on planned post-closure usage and reclamation types, outlined in the Project Reclamation Plan.

3.8 Permits and Approvals

Table 3-18 through Table 3-20 describes the primary permits that may be required for the Project. The tables are organized to identify the regulatory agency responsible, the permit or approval considered, and the status of the approval.

Table 3-18 Federal Government Permits and Approvals

Agency or Organization	Permit/Approval	Status
Bureau of Land Management	Federal Preference Right Leases	Pending
Bureau of Land Management	Mine Plan of Operations	Pending
U.S. Forest Service	Road Use Permit	To be applied for, if needed
U.S. Forest Service	Special Use Permit	To be applied for
Bureau of Land Management/U.S. Forest Service/U.S. Army Corps of Engineers	Section 106 of the National Historic Preservation Act Consultation	Consultation will occur with Tribal Historic Preservation Officer/State Historic Preservation Office, as appropriate
U.S. Fish and Wildlife Service	Section 7 Endangered Species Act Compliance	Consultation will occur with U.S. Fish and Wildlife Service, as appropriate, to comply with Endangered Species Act.
U.S. Army Corps of Engineers	Section 404 Dredge and Fill Permit	To be applied for, if needed
U.S. Environmental Protection Agency	Type V Underground Injection Control	To be applied for, if needed

Table 3-19 State Government Permits and Approvals

Agency or Organization	Permit/Approval	Status
Minnesota Department of Natural Resources	Permit to Mine	To be applied for
Minnesota Department of Natural Resources	Minnesota Wetlands Conservation Act	To be applied for
Minnesota Department of Natural Resources	Easement Across State-Owned Land Managed by the Minnesota Department of Natural Resources	To be applied for, if needed
Minnesota Department of Natural Resources	Dam Safety Permit	To be applied for, if needed
Minnesota Department of Natural Resources	License to Cross Public Lands and Waters	To be applied for
Minnesota Department of Natural Resources	Water Appropriation Permit	To be applied for
Minnesota Department of Natural Resources	Permit for Work in Public Waters (water intake, outfall, new culverts, and replacement culverts)	To be applied for, if needed
Minnesota Department of Natural Resources	Burning - Burning Permit	To be applied for
Minnesota Department of Natural Resources	Lease or Land Exchange to use State Surface	To be applied for
Minnesota Department of Natural Resources	Take of Endangered or Threatened Species Incidental to a Development Project	To be applied for, if needed
Minnesota Department of Health	Drinking Water - Noncommunity/Nontransient Public Water Supply System	To be applied for, if needed
Minnesota Department of Health	Hazardous Materials - Radioactive Material License (for measuring equipment)	To be applied for, if needed
Minnesota Pollution Control Agency	Synthetic Minor Air Emissions Permit	To be applied for
Minnesota Pollution Control Agency	Hazardous Waste Generator Notification/License	To be applied for, if needed
Minnesota Pollution Control Agency	Hazardous Waste Treatment, Storage or Disposal Facility Permit	To be applied for, if needed
Minnesota Pollution Control Agency	National Pollution Discharge Elimination System / State Disposal System - Construction Stormwater Permit	To be applied for
Minnesota Pollution Control Agency	National Pollution Discharge Elimination System / State Disposal System - Industrial Stormwater Permit	To be applied for
Minnesota Pollution Control Agency	Tanks - General Storage Tank Registration	To be applied for
Minnesota Pollution Control Agency	401 Water Quality Certification	To be applied for

Table 3-20 Local Government Permits and Approvals

Agency or Organization	Permit/Approval	Status
Lake County Planning and Zoning	Conditional Use - Conditional Use Permit	To be applied for, if needed
Lake County Highway Department	Access Road/Driveway - Access Driveway Permit	To be applied for, if needed
St. Louis County Planning and Community Development	Landscape Alteration - Land Alteration Permit	To be applied for, if needed
St. Louis County Planning and Community Development	Entrance Permit (Driveway Access)	To be applied for, if needed
St. Louis County Planning and Community Development	Conditional Use - Conditional Use Permit	To be applied for, if needed
St. Louis County Environmental Service	Building Construction - Building Permit	To be applied for, if needed
City of Babbitt Zoning Office	Sign Permit - Sign Permit	To be applied for, if needed

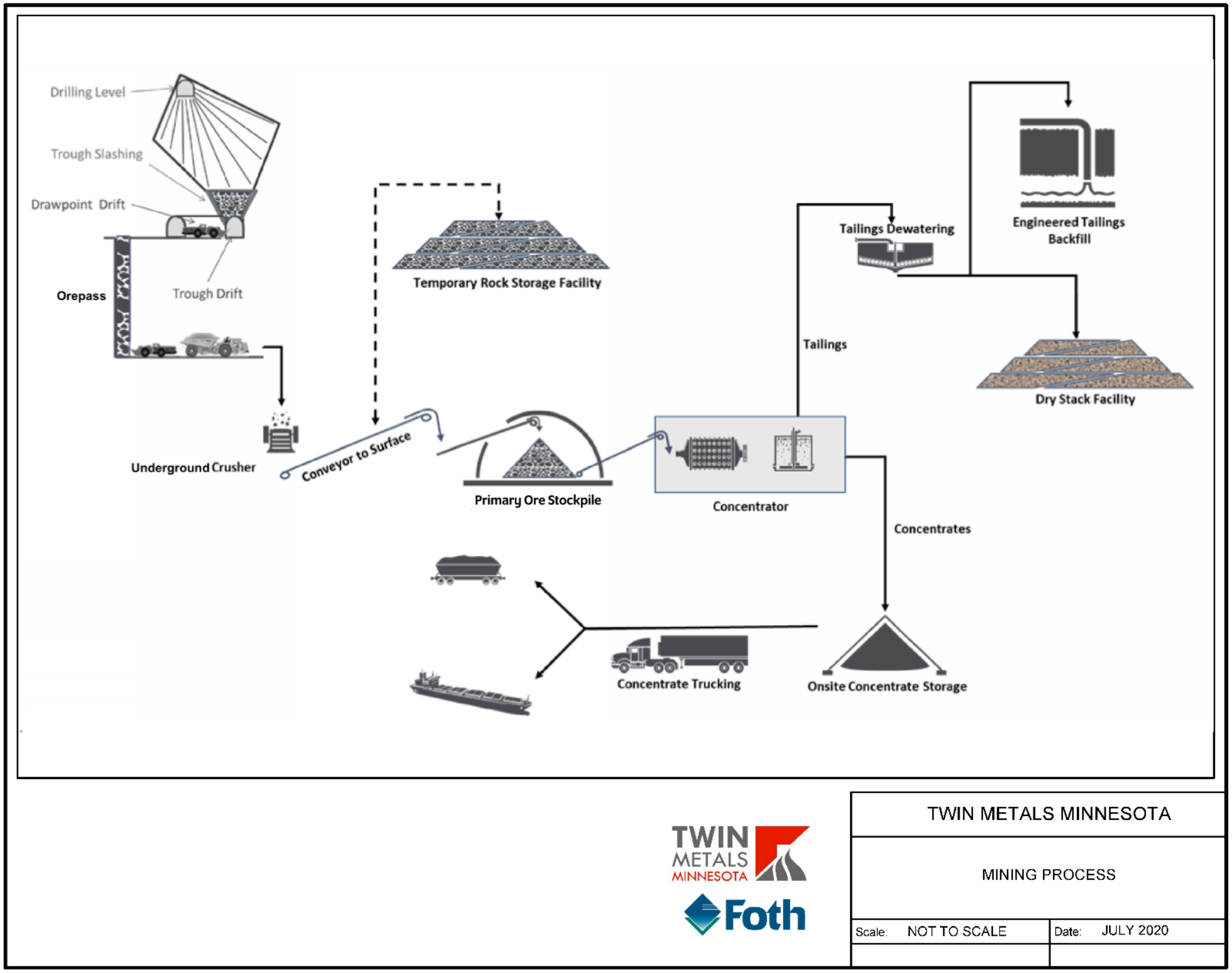


Figure 3-1 Mining Process

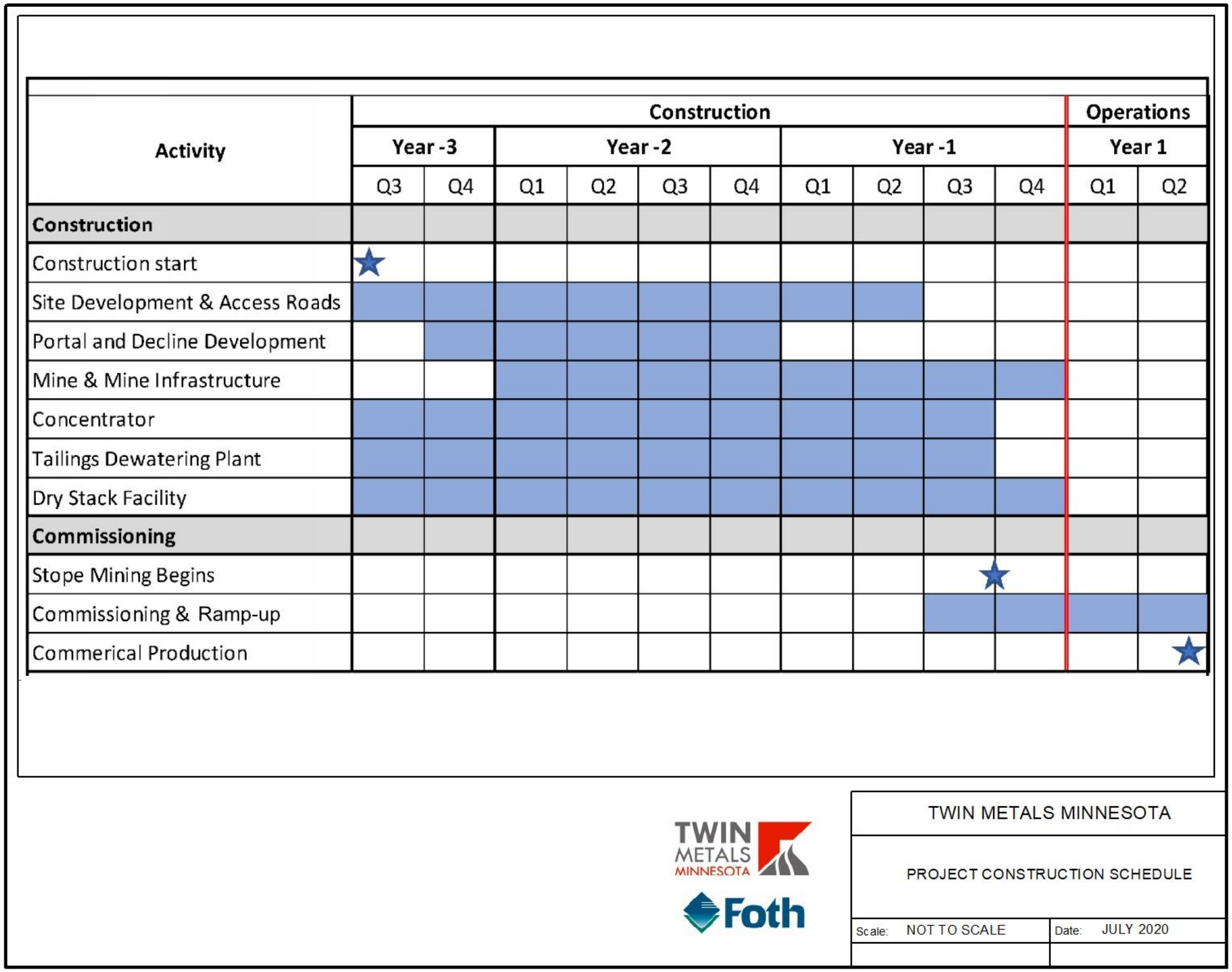
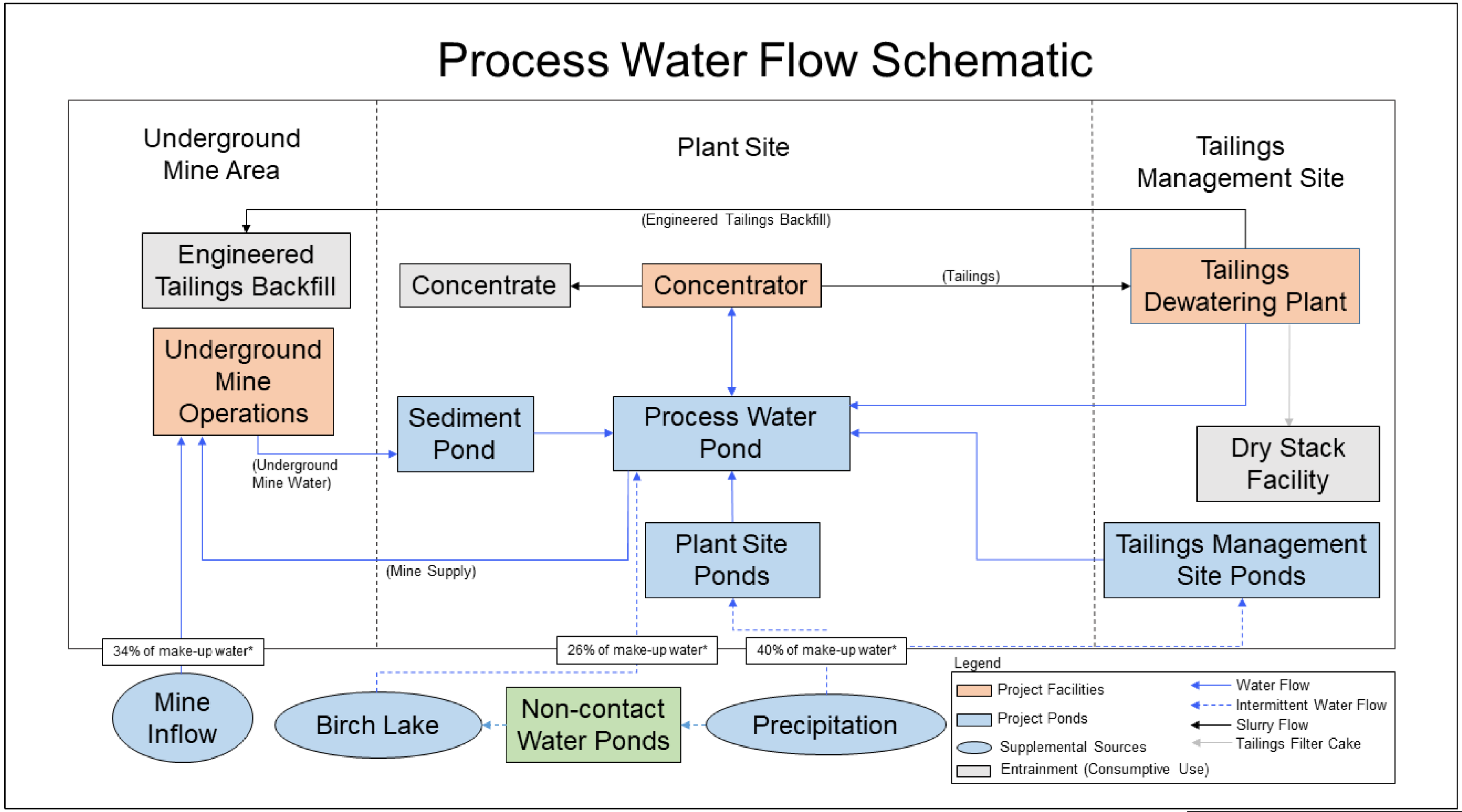


Figure 3-2 Project Construction Schedule



NOTES:
1. *These percentages vary throughout the life of mine and percentages for a typical year are shown.
2. The non-contact water ponds would not be constructed ponds.
3. During typical precipitation periods, industrial stormwater (ISW) would be used as needed in the process. However, when the Project has excess water, ISW at the tailings management site ponds and the plant site ponds could be routed through appropriate discharge controls and discharged to the environment in accordance with applicable regulatory requirements and appropriate BMPs.

TWIN METALS MINNESOTA	
SIMPLIFIED PROJECT WATER SCHEMATIC	
Scale: NOT TO SCALE	Date: MARCH 2021

Figure 3-3 Simplified Project Water Schematic

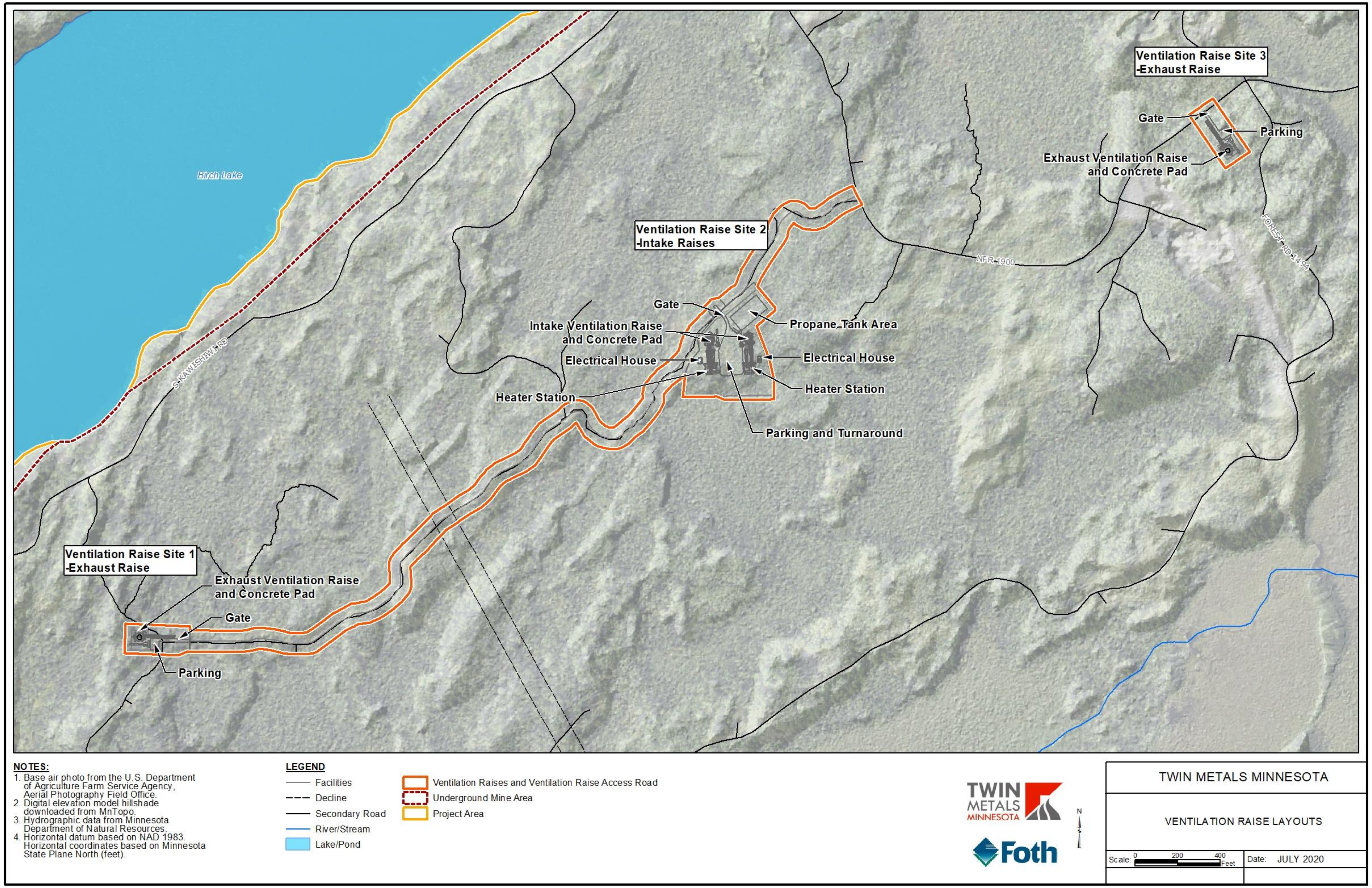


Figure 3-4 Ventilation Raise Layouts

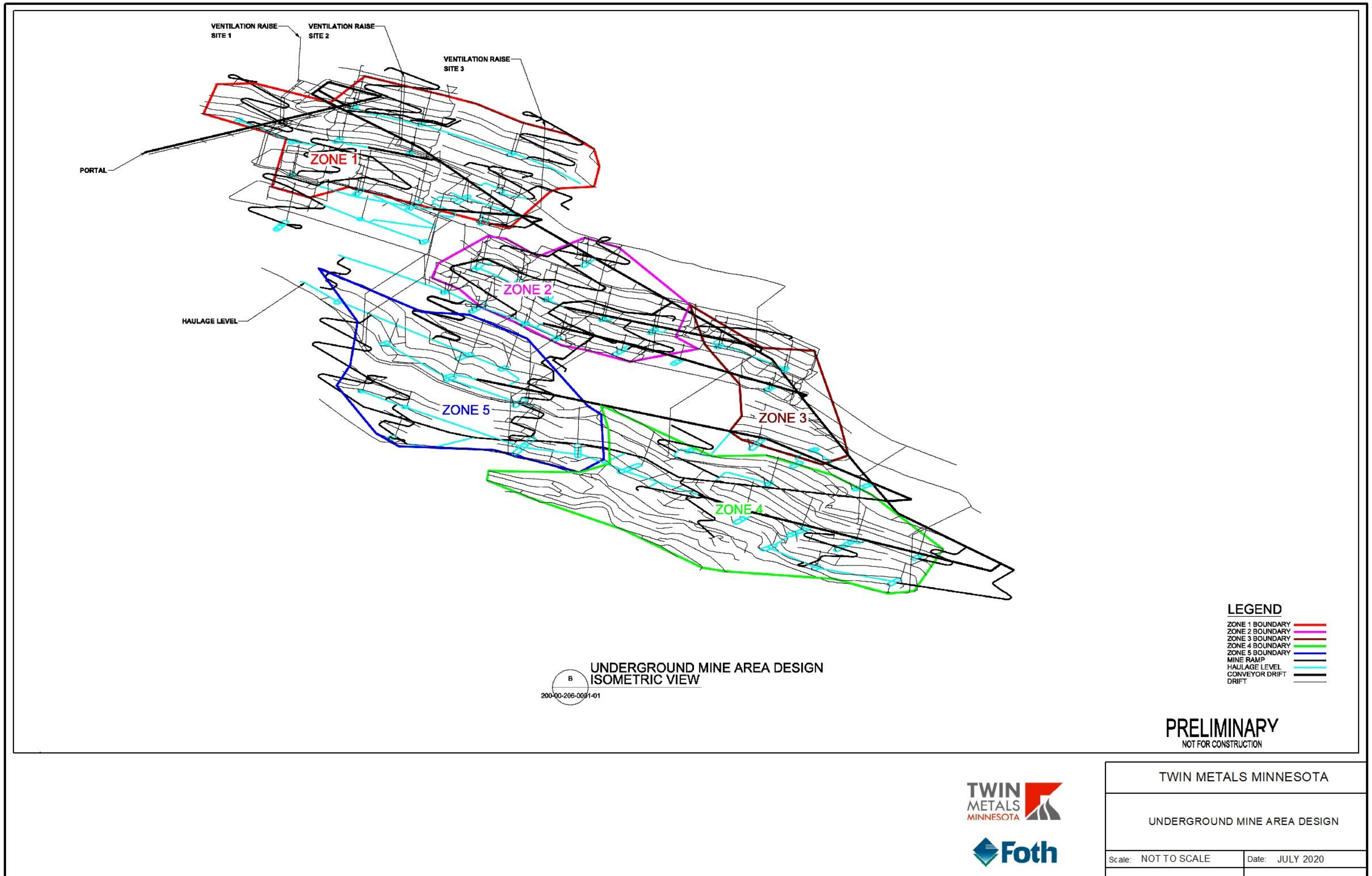
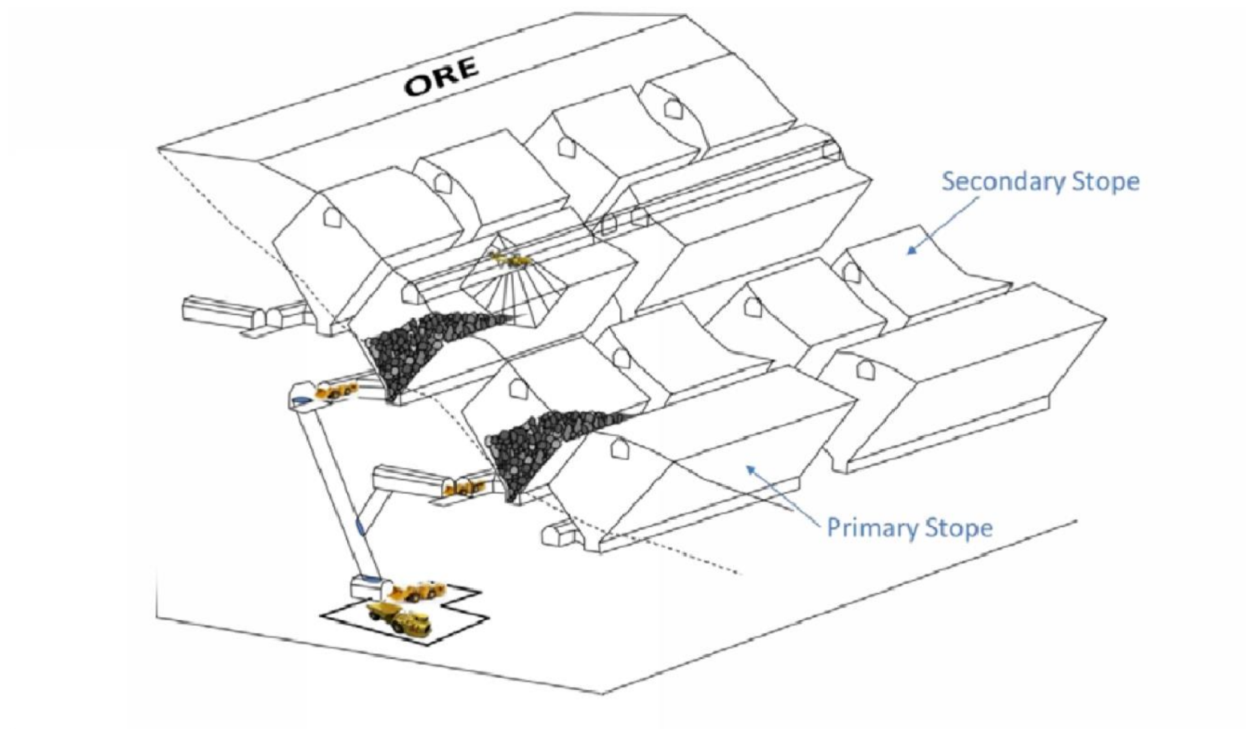


Figure 3-5 Underground Mine Area Design

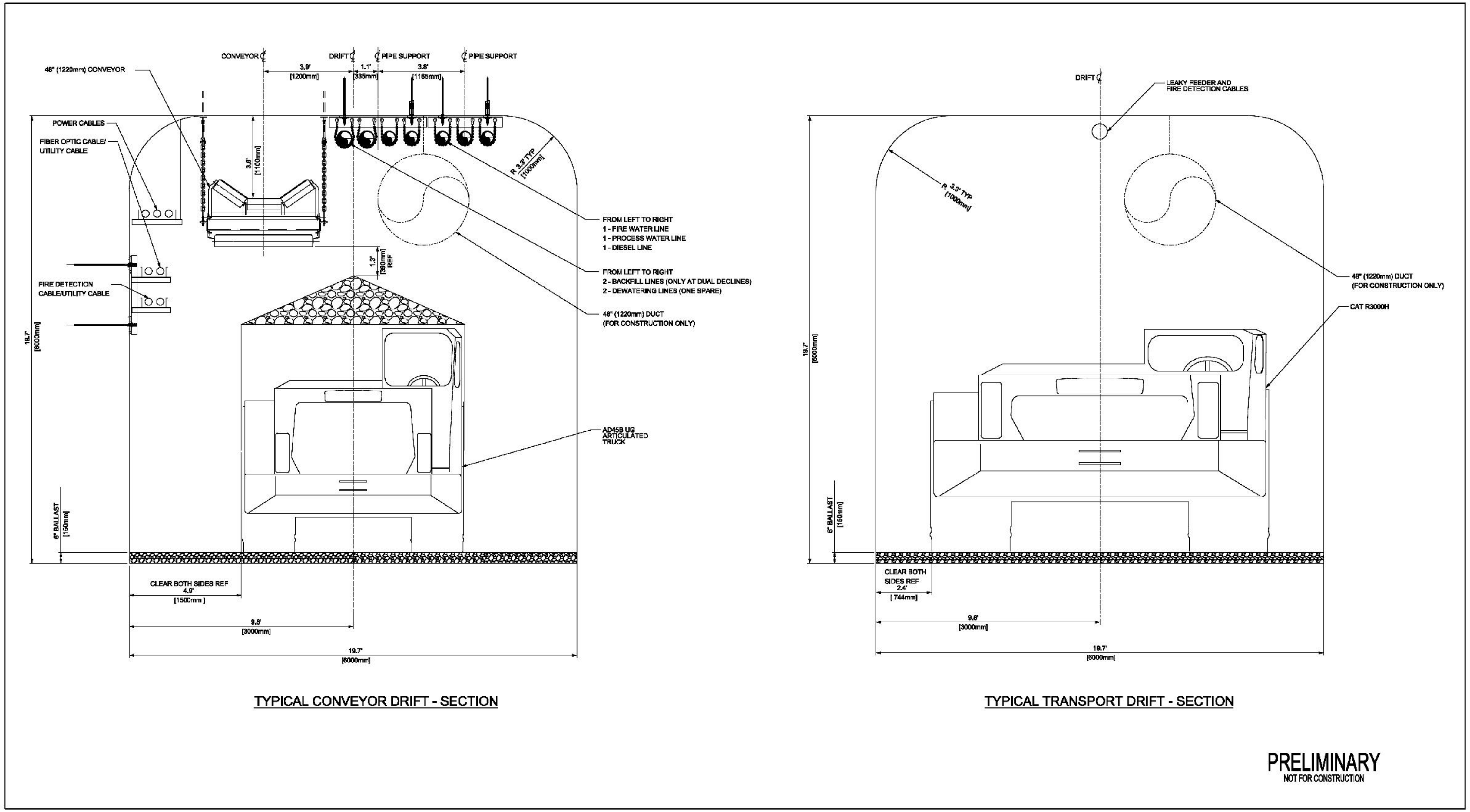


TWIN METALS MINNESOTA

MINING METHOD SCHEMATIC

Scale: NOT TO SCALE | Date: JULY 2020

Figure 3-6 Mining Method Schematic

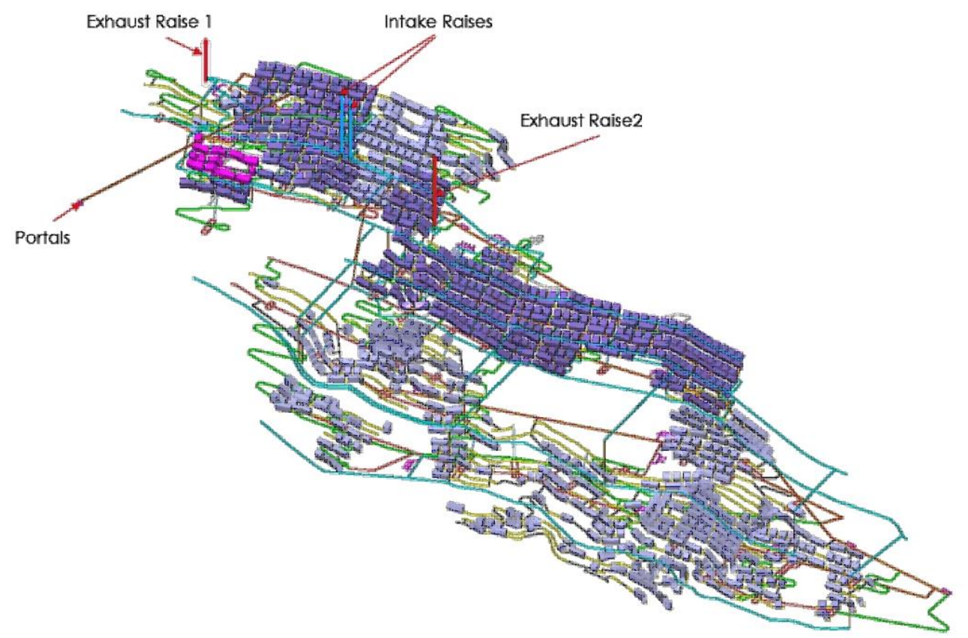


TWIN METALS MINNESOTA

MINE DESIGN TYPICAL DRIFT SECTIONS

Scale: NOT TO SCALE | Date: JULY 2020

Figure 3-7 Mine Design Typical Drift Sections



TWIN METALS MINNESOTA

MATURI 25-YEAR MINE DESIGN

Scale: NOT TO SCALE | Date: JULY 2020

Figure 3-8 Maturi 25-Year Mine Design

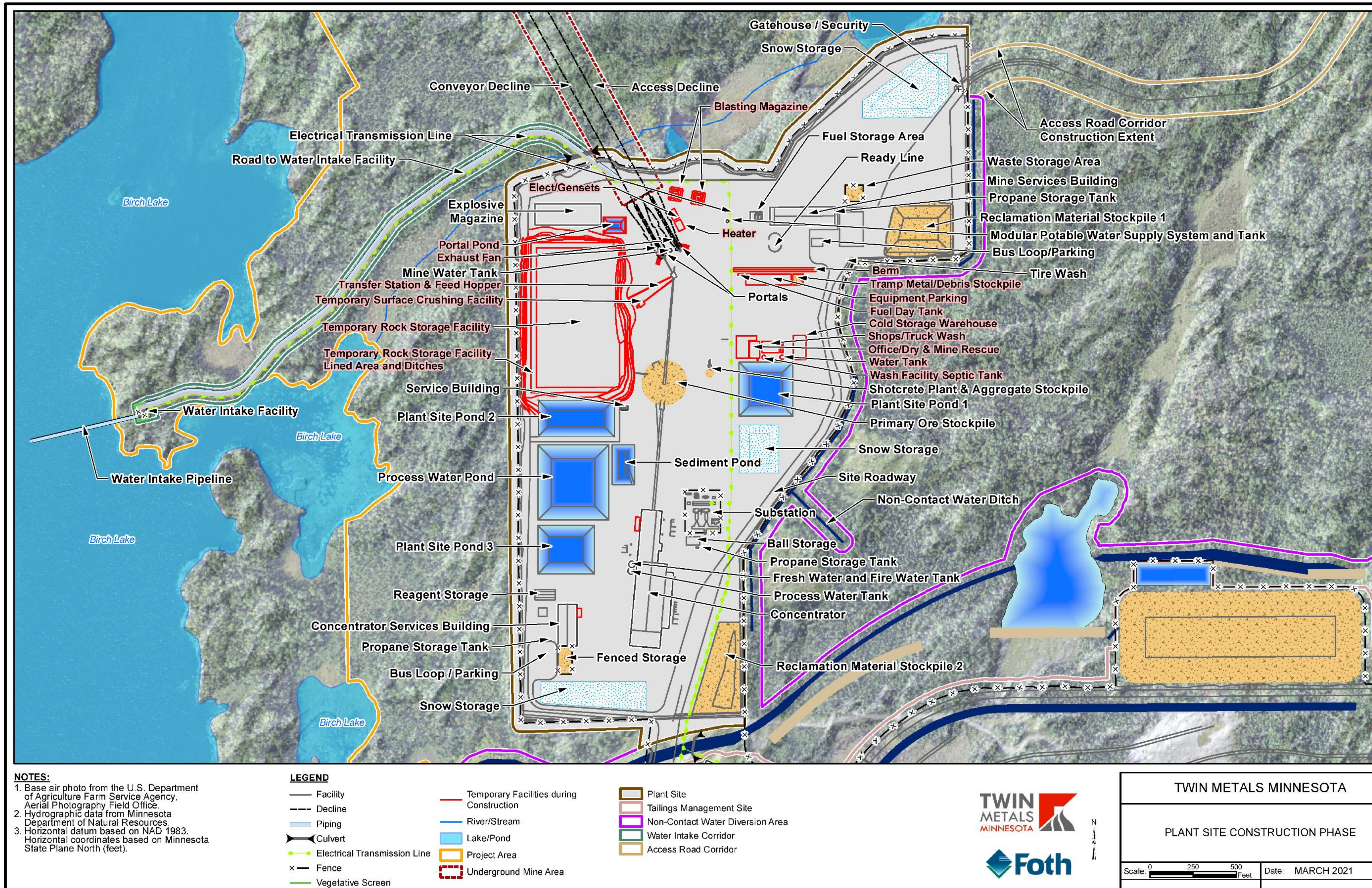


Figure 3-9 Plant Site Construction Phase

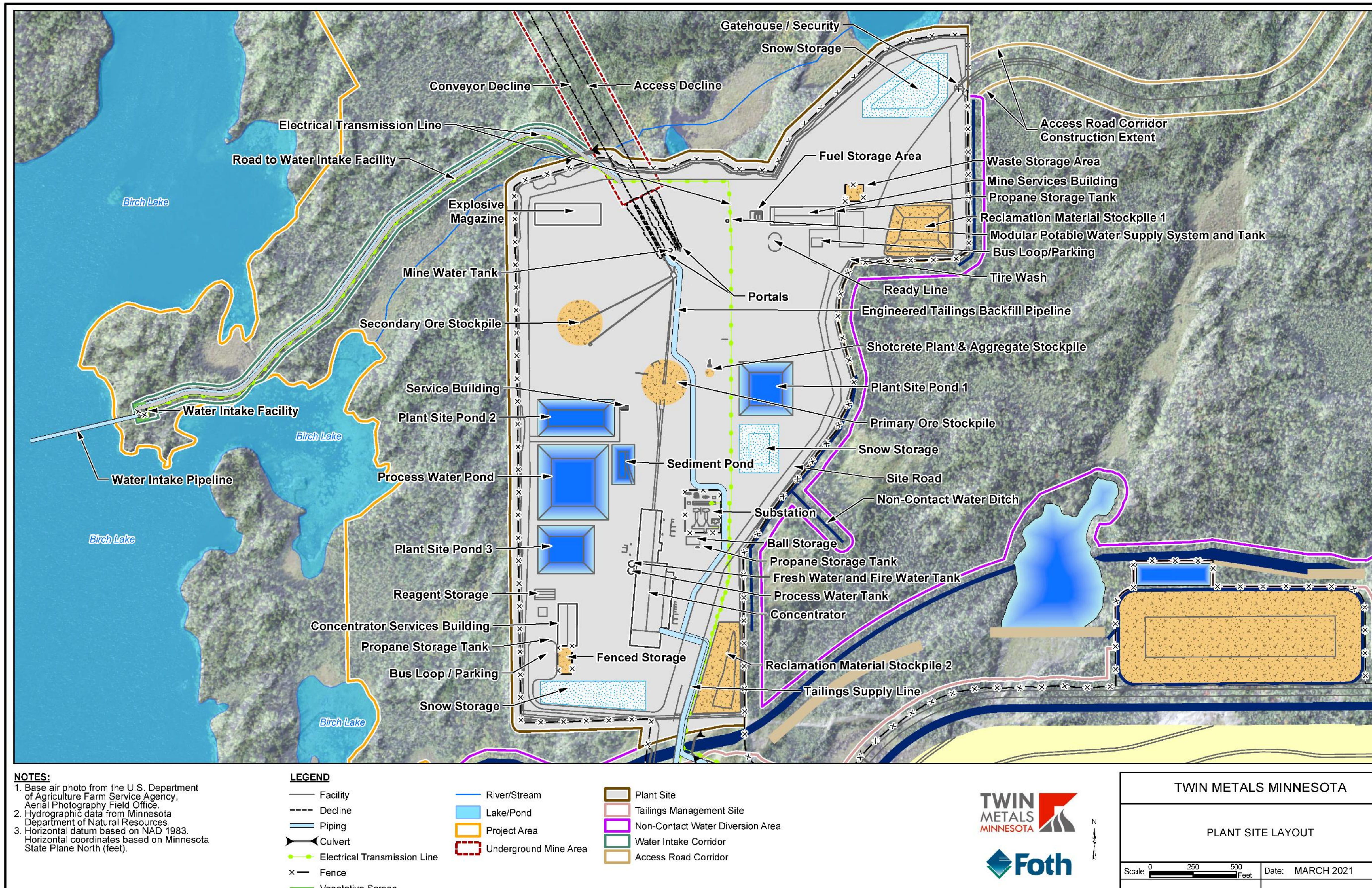
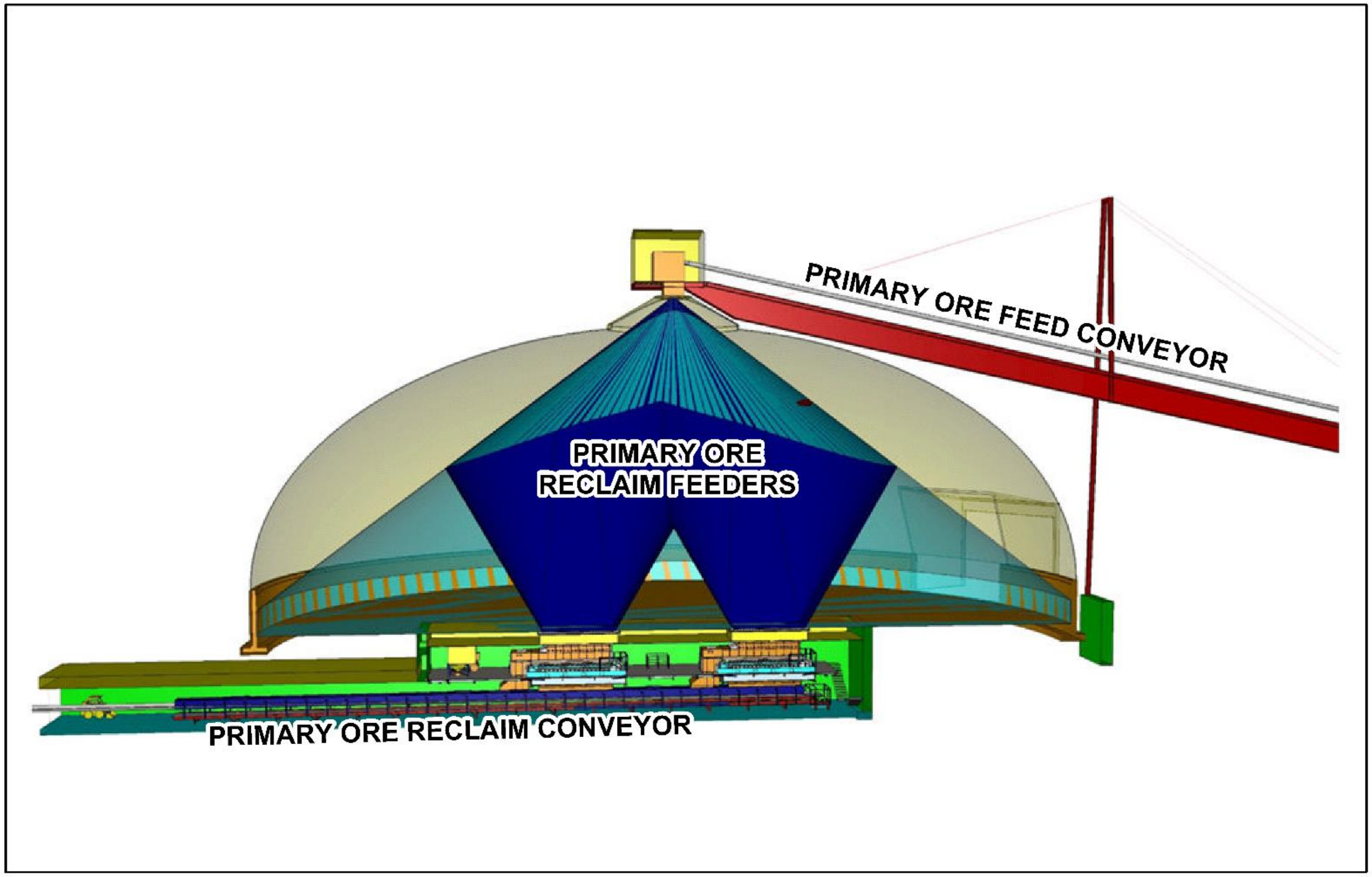


Figure 3-10 Plant Site Layout



TWIN METALS MINNESOTA	
PRIMARY ORE STOCKPILE SECTION VIEW	
Scale: NOT TO SCALE	Date: MARCH 2021

Figure 3-11 Primary Ore Stockpile Section View

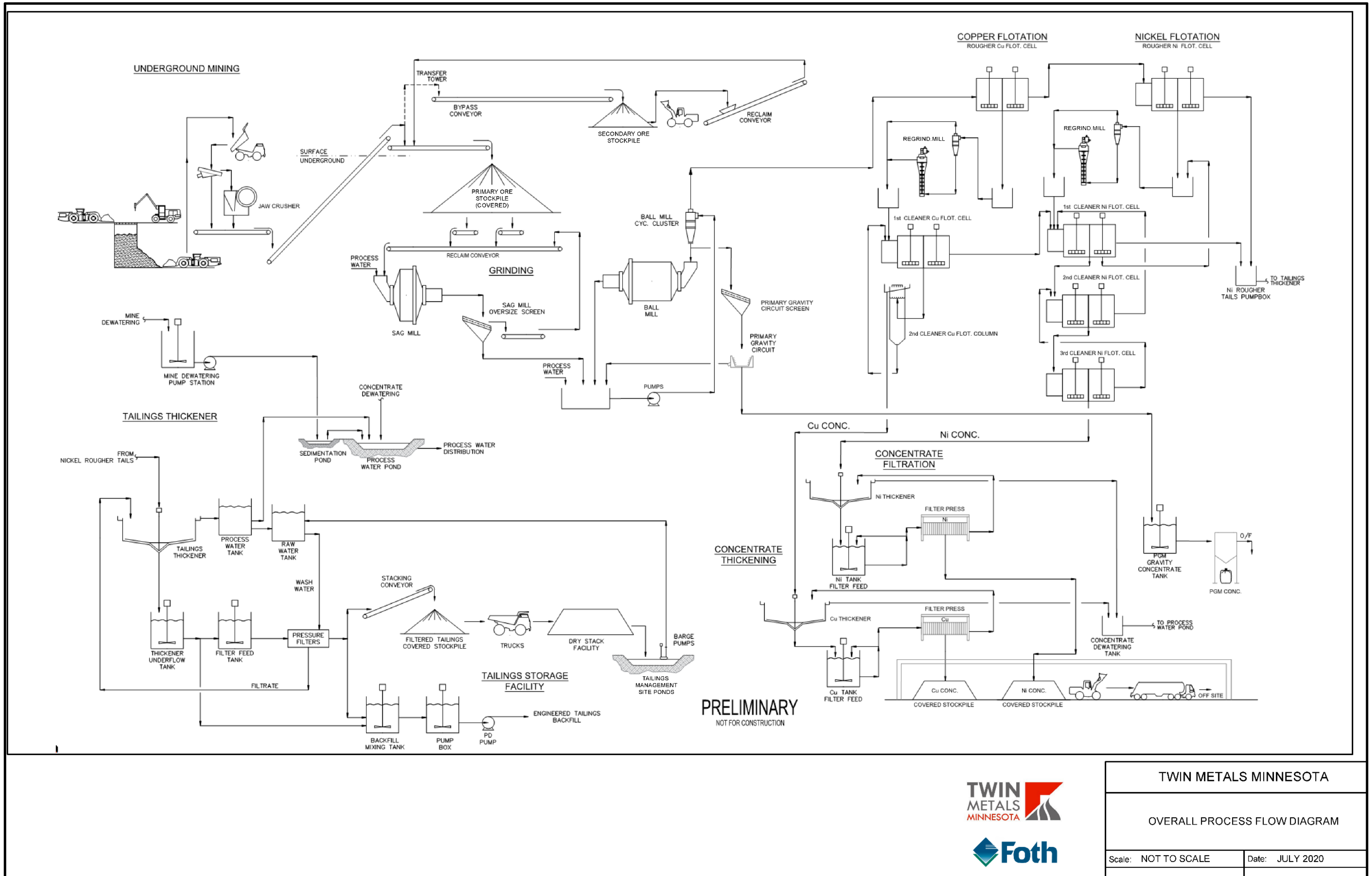


Figure 3-12 Overall Process Flow Diagram

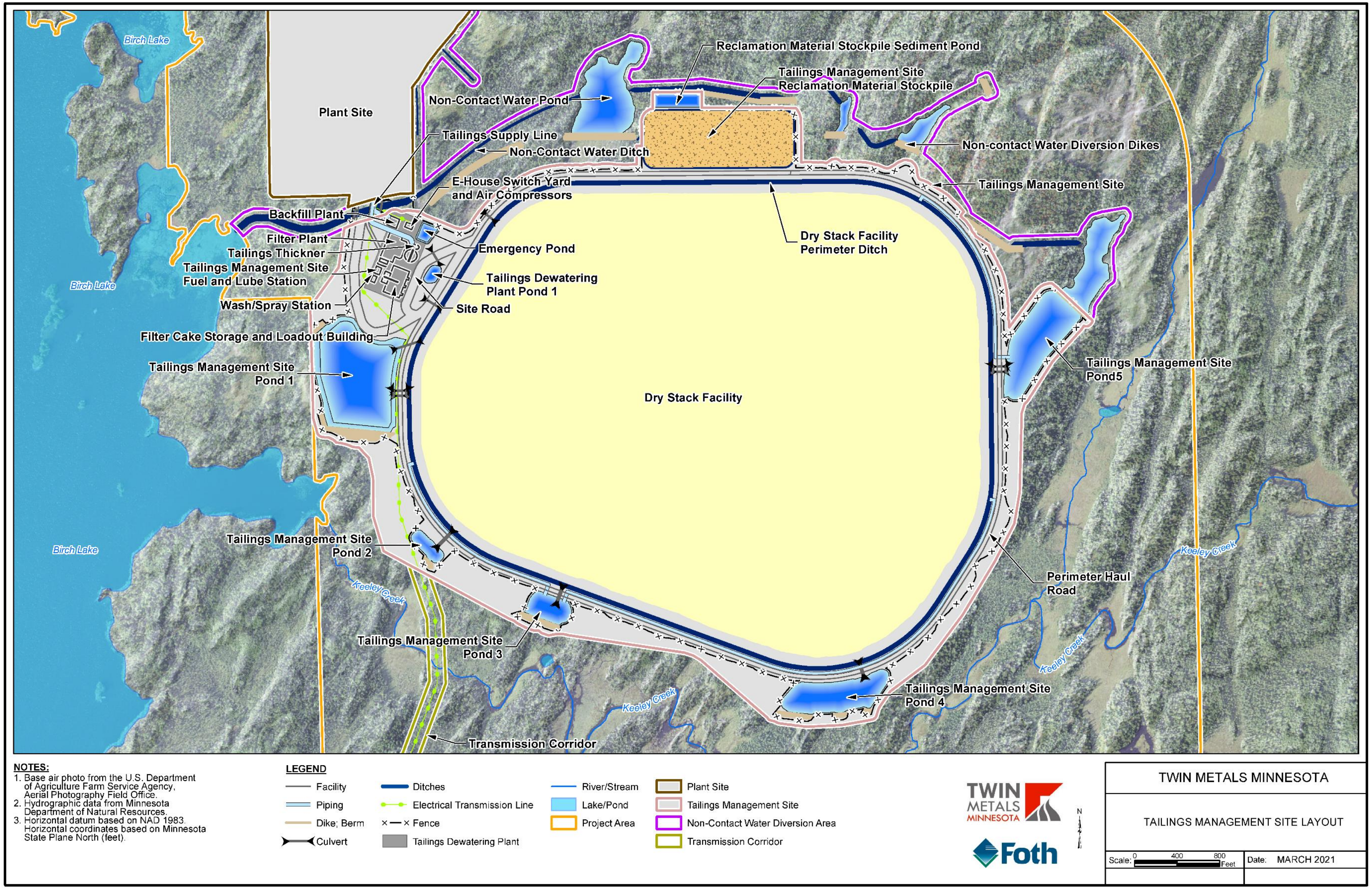


Figure 3-13 Tailings Management Site Layout

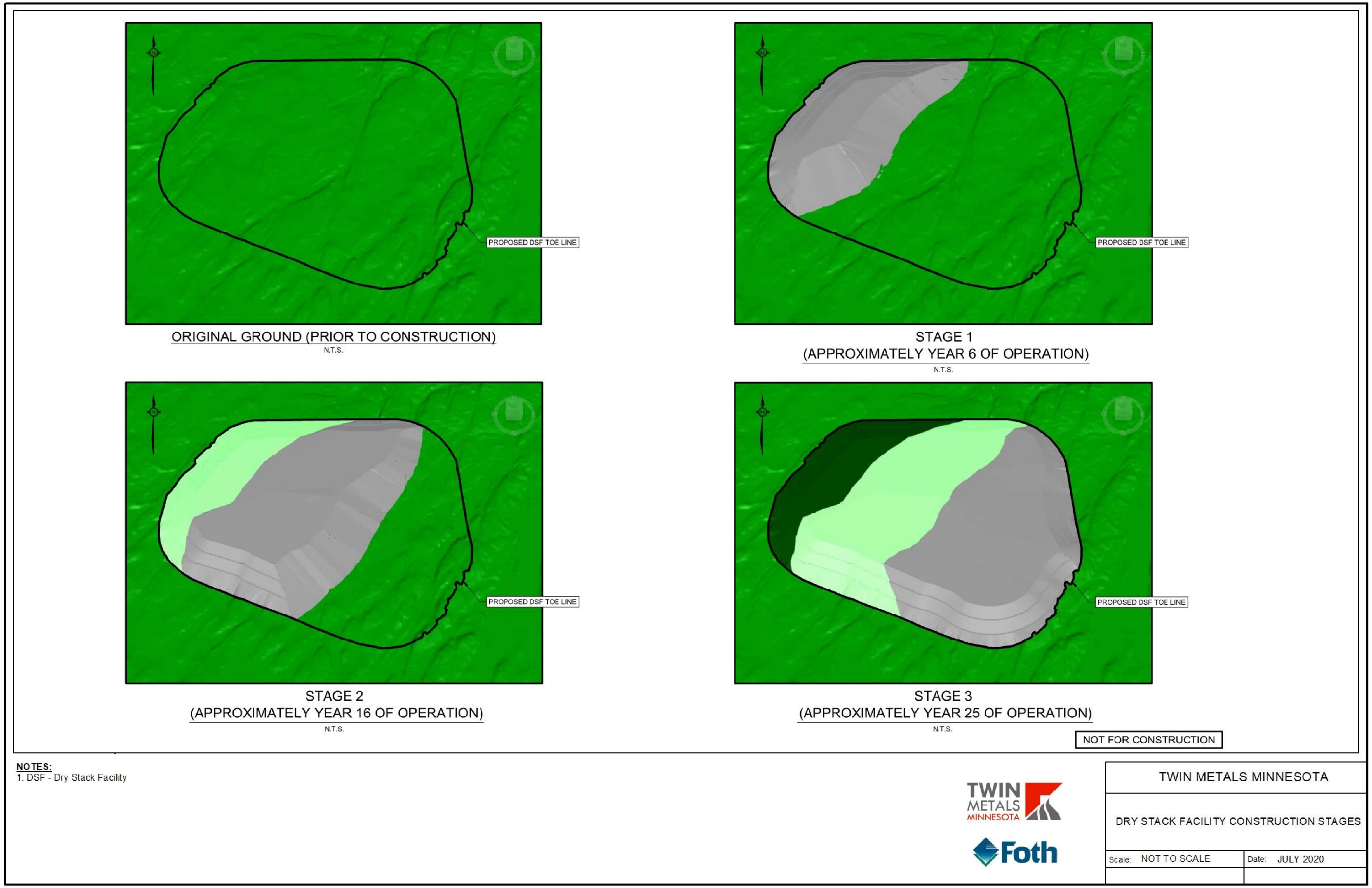


Figure 3-14 Dry Stack Facility Construction Phases

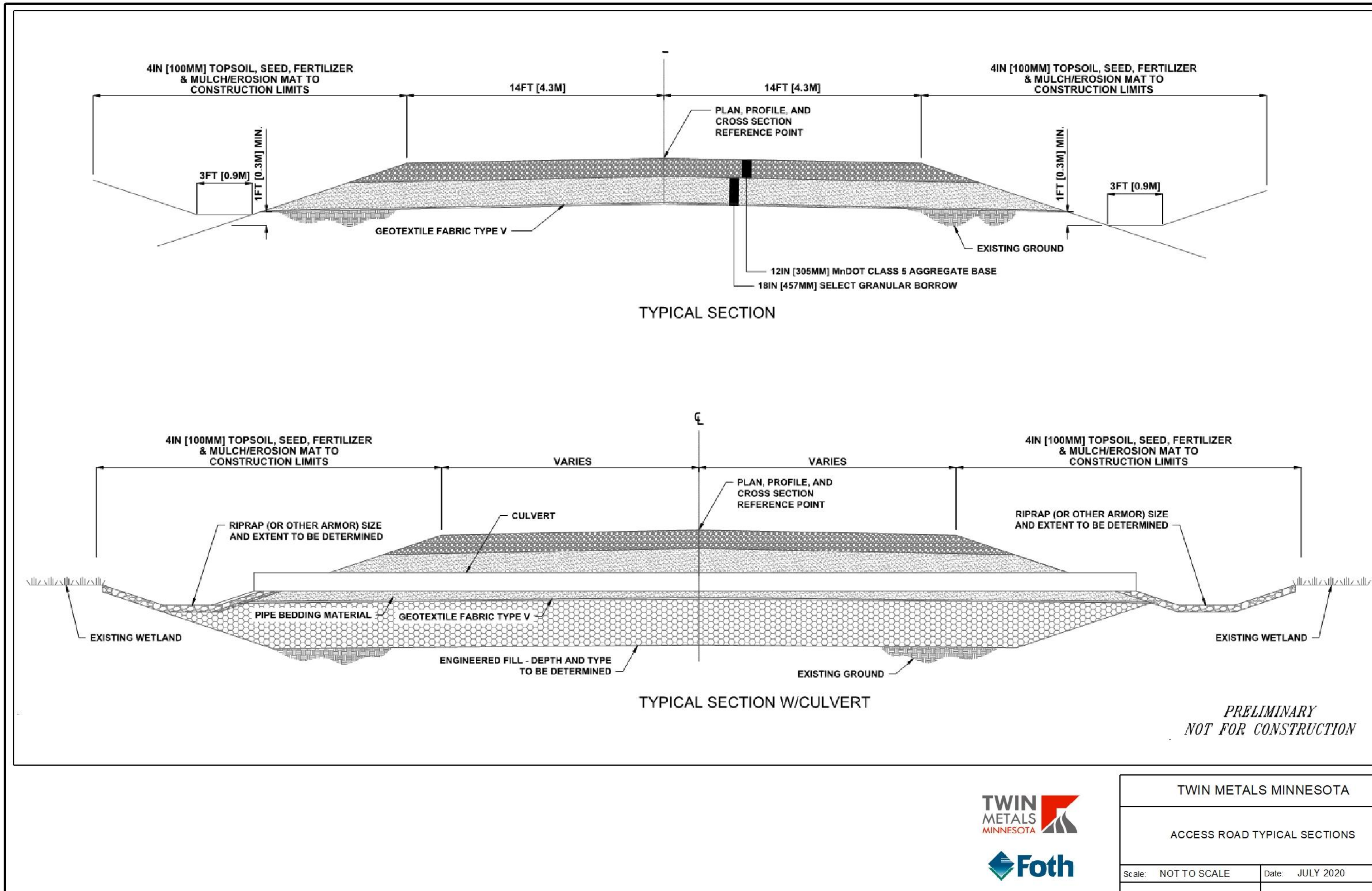


Figure 3-15 Access Road Typical Sections

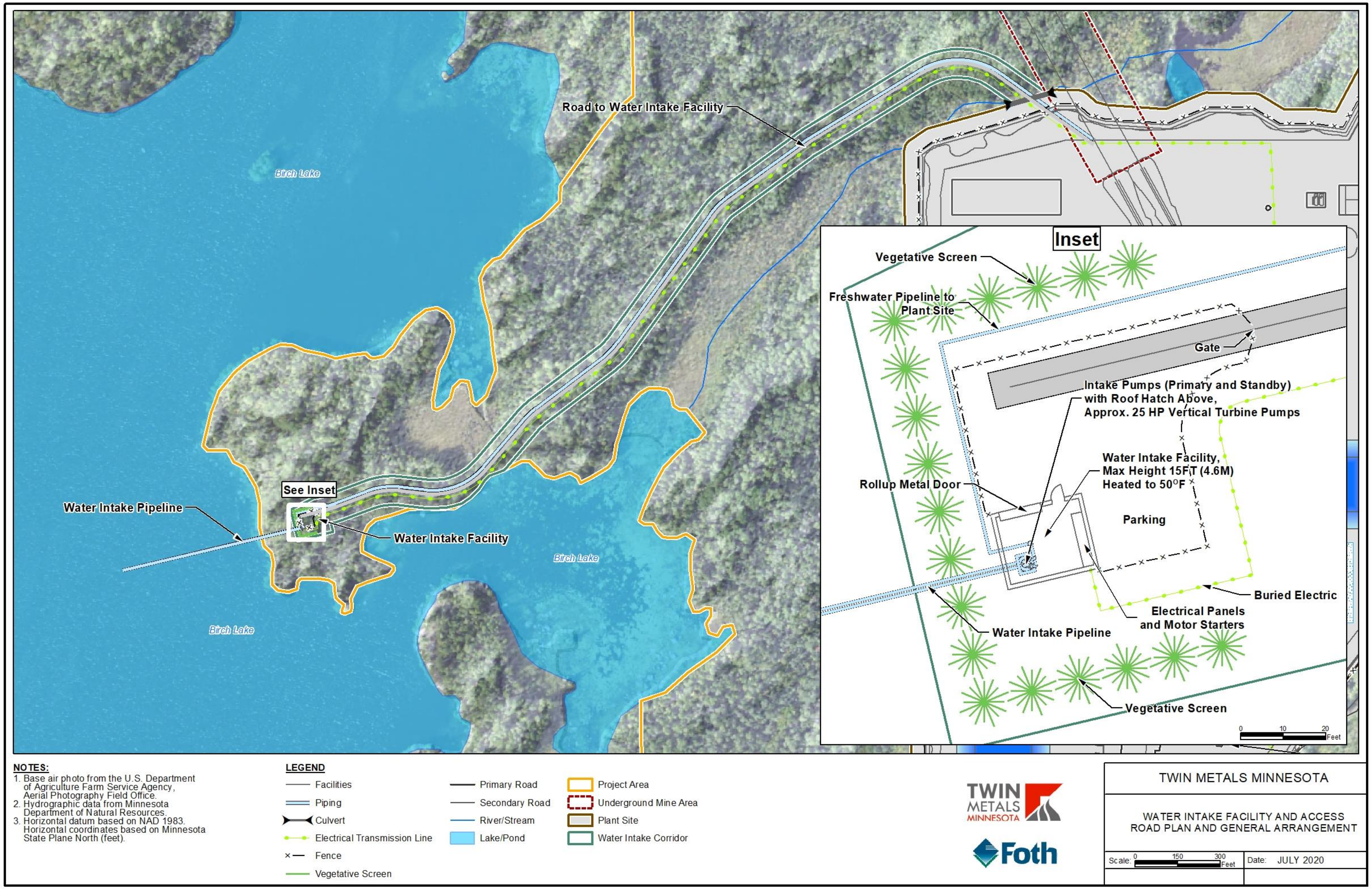
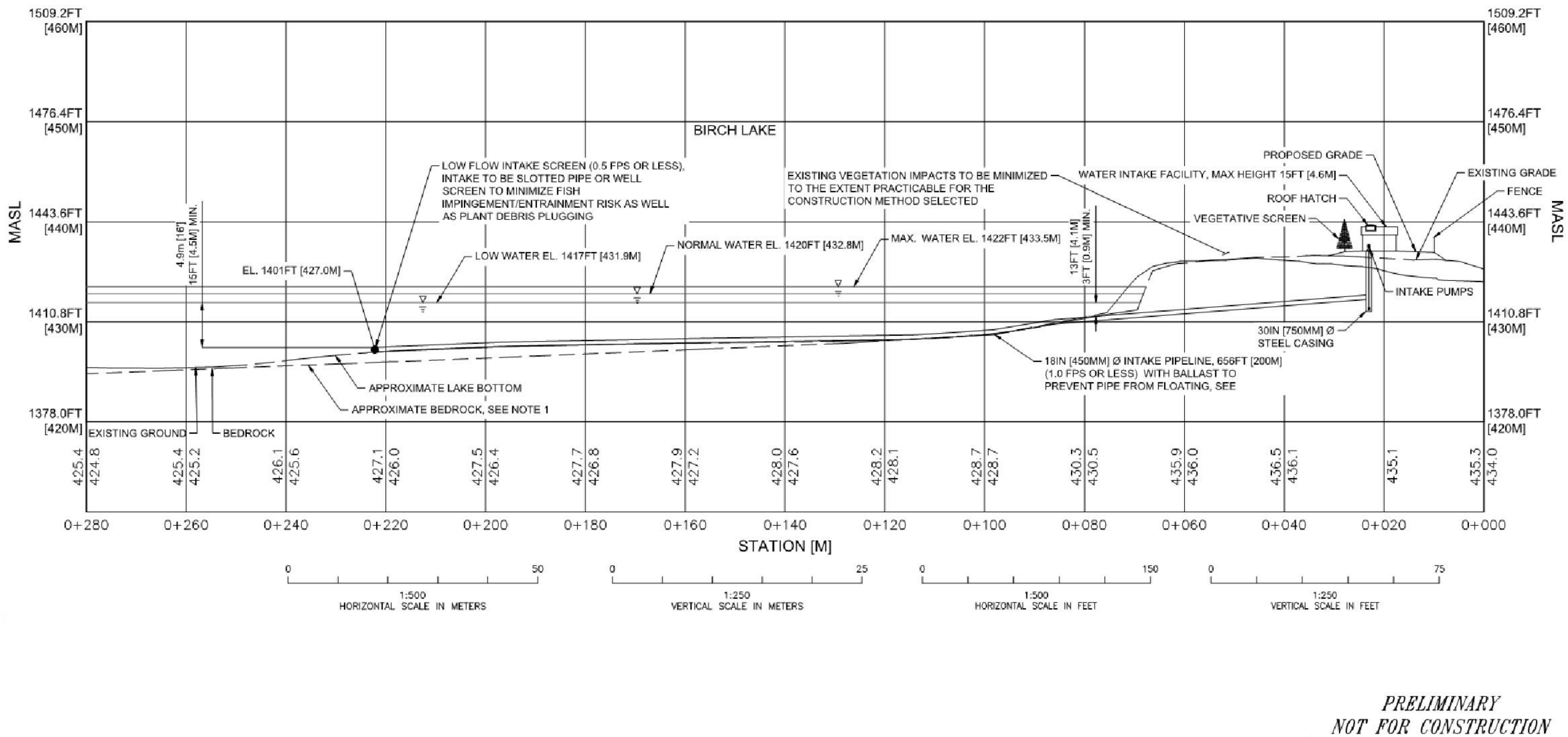


Figure 3-16 Water Intake Facility and Access Road Plan and General Arrangement

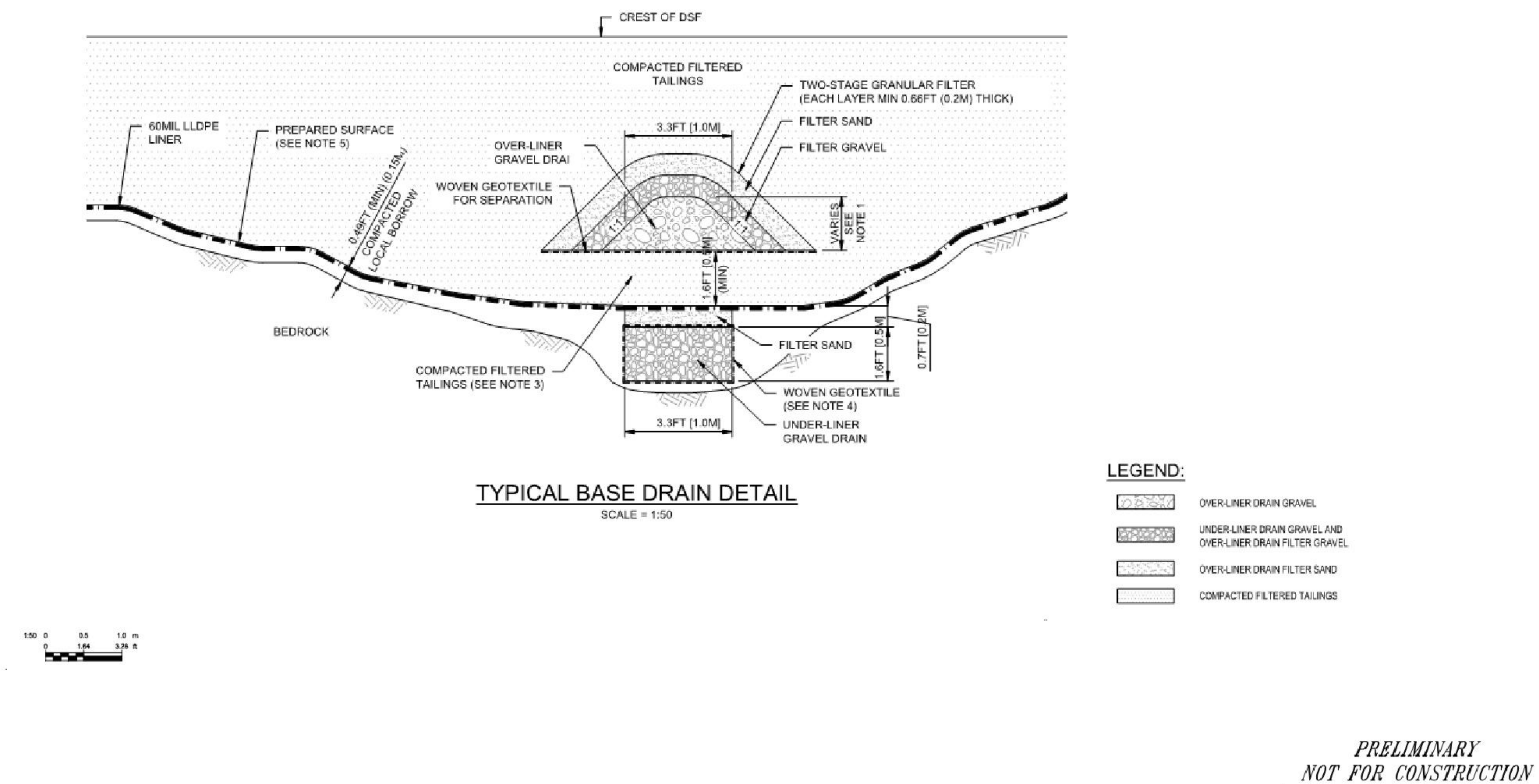


Notes

1. TOP OF BEDROCK ESTIMATES SHOWN IN THE PROFILES ARE BASED ON DATA FROM THE MINNESOTA GEOLOGICAL SURVEY (OFR2016-04) DOWNLOADED FEBRUARY 12, 2018.

TWIN METALS MINNESOTA	
WATER INTAKE FACILITY PLAN, PROFILE, SECTIONS, AND DETAILS	
Scale: SEE ABOVE	Date: JULY 2020

Figure 3-17 Water Intake Facility Plan, Profile, Sections, and Details

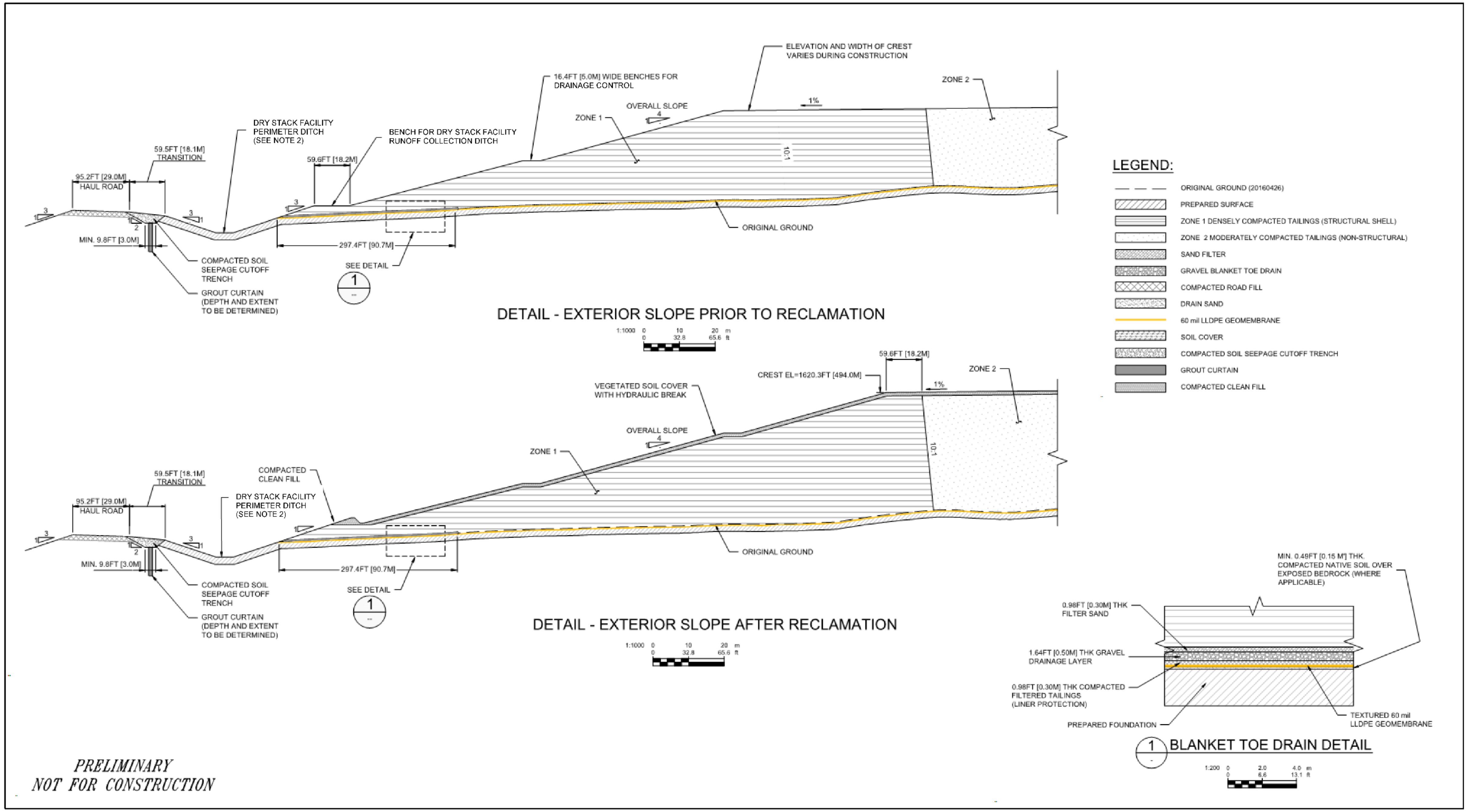


NOTES:

1. DIMENSIONS AND ELEVATIONS ARE IN FEET [METERS].
2. DIMENSIONS OF OVER-LINER DRAINS VARY. REQUIRED CROSS-SECTION OF GRAVEL FOR FEEDER DRAINS IS 5.4FT² [0.5M²] (AVERAGE WIDTH=3.3FT [1.0M], HEIGHT=1.6FT [0.5M]). ARTERIAL DRAINS HAVE LARGER CROSS-SECTIONAL AREA THAT VARIES DEPENDING ON CONTRIBUTING DRAIN CATCHMENT AREA.
3. DIMENSIONS OF UNDER-LINER DRAINS VARY. REQUIRED CROSS-SECTION OF GRAVEL FOR FEEDER DRAINS IS 5.4FT² [0.5M²] (WIDTH-3.3FT [1.0M], HEIGHT=1.6FT [0.5M]). ARTERIAL DRAINS HAVE LARGER CROSS-SECTIONAL AREA THAT VARIES DEPENDING ON CONTRIBUTING DRAIN CATCHMENT AREA.
4. 1.6FT [0.5M] THICK LAYER OF COMPACTED TAILINGS PLACED OVER THE GEOMEMBRANE PRIOR TO PLACING OVER-LINER DRAIN.
5. WOVEN GEOTEXTILE WILL BE USED FOR SEPARATION, NOT FILTRATION.
6. FOUNDATION TO BE STRIPPED OF TOPSOIL, ORGANICS AND UNSUITABLE MATERIALS. FOUNDATION SHALL HAVE AN ALLOWABLE BEARING PRESSURE OF 150 kPa TO SUPPORT LINER SYSTEM. A BEDDING LAYER OF LOCAL, SUITABLE BORROW, MINIMUM 0.5FT [0.15M] THICK WILL BE PLACED AND DENSELY COMPACTED OVER ANY EXPOSED BEDROCK.

TWIN METALS MINNESOTA	
BASE DRAIN DETAILS	
Scale: AS SHOWN	Date: JULY 2020

Figure 3-18 Base Drain Details



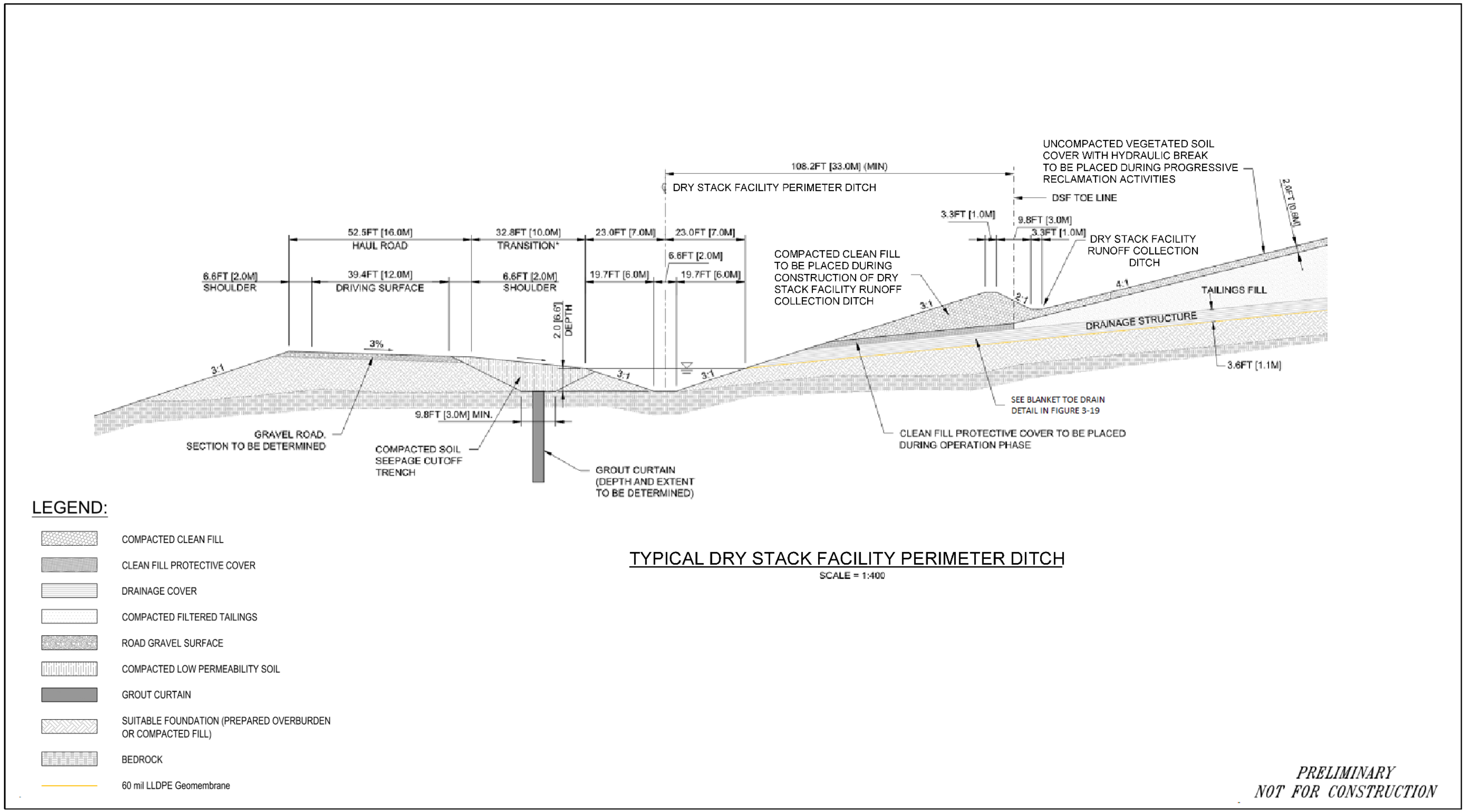
NOTES:
1. ORIGINAL GROUND SURVEY PROVIDED BY TWIN METALS MINNESOTA, RECEIVED ON APRIL 26, 2016.
2. SEEPAGE CUTOFF SURFACE WILL HAVE GRASS VEGETATION IN SOME LOCATIONS, RIPRAP ARMOUR IN OTHERS AND EXPOSED BEDROCK IN OTHERS.

TWIN METALS MINNESOTA

TYPICAL CROSS-SECTION OF EXTERIOR SLOPE

Scale: AS SHOWN | Date: MARCH 2021

Figure 3-19 Typical Cross-section of Exterior Slope



NOTES:
ABOUT TRANSITION SLOPE:
SLOPES THROUGH TRANSITION WILL VARY DEPENDING ON MATERIAL AS FOLLOWS:
1. FOR FILL CONDITION: FROM 3% TO 3(H):1(V)
2. FOR CUT CONDITION (THROUGH OVERBURDEN): FROM 3% TO 3(H):1(V)
3. FOR CUT CONDITION (THROUGH BEDROCK): FROM 3% TO 1(H):1(V)

TWIN METALS MINNESOTA	
TYPICAL DITCH SECTIONS	
Scale: NOT TO SCALE	Date: MARCH 2021

Figure 3-20 Typical Ditch Sections

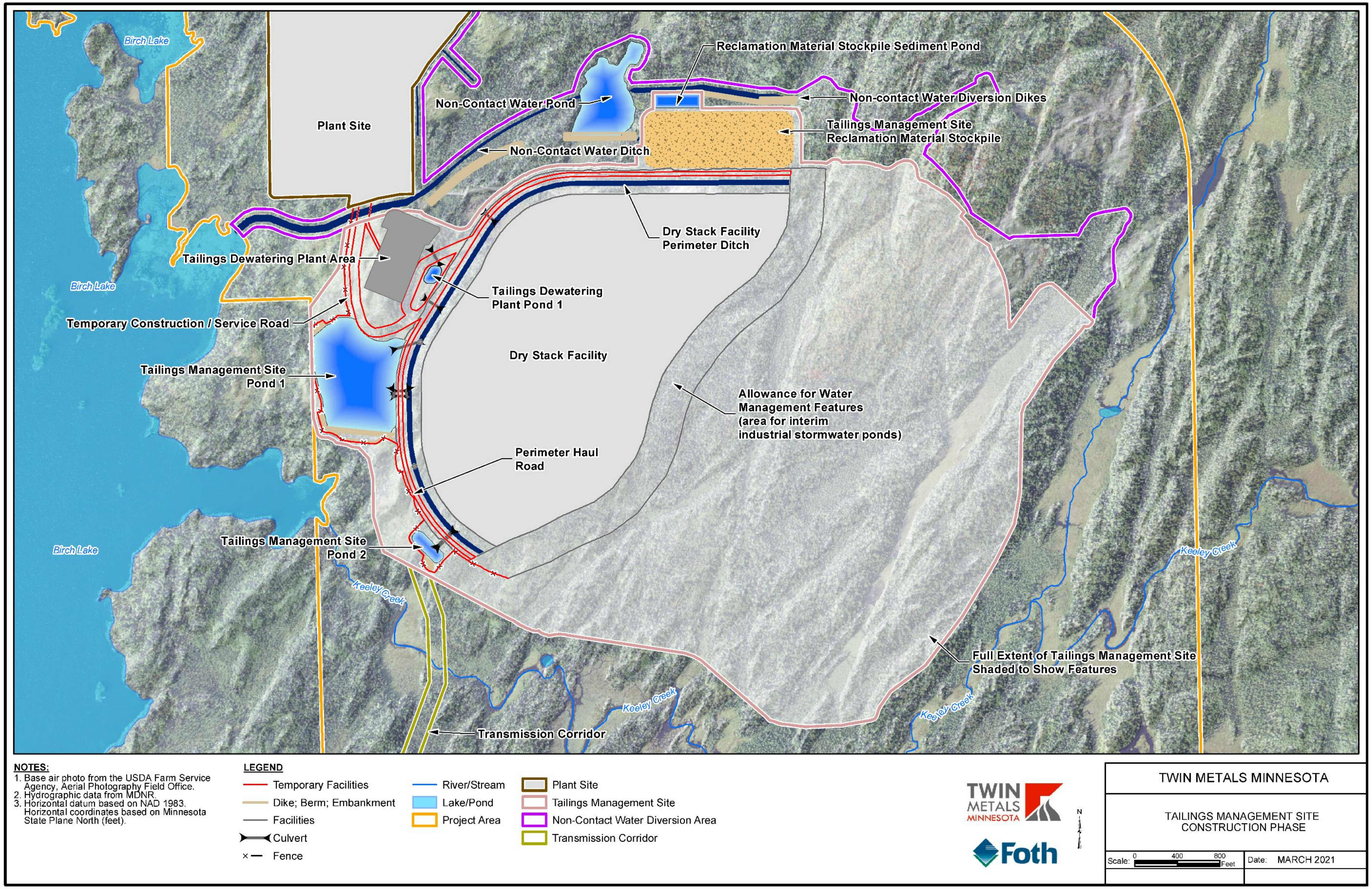


Figure 3-21 Tailings Management Site Construction Phase

4.0 LAND USE

4.1 Baseline Conditions

4.1.1 Existing Land Use

The Project area would be in both Lake and St. Louis Counties on a mix of uplands and forested wetlands within the Superior National Forest (SNF). The landscape surrounding the Project area is primarily characterized by undeveloped, forested uplands and wetlands to the north, east, and south, with Birch Lake located to the west. A portion of the Project area includes School Trust Land within the Bear Island State Forest. School Trust Lands are state-owned lands which are set aside to provide a continual source of funding for public education. Revenue from School Trust Lands is generated from sale and lease of the lands and minerals, and resource extraction through timber sales and mineral royalties. Within the vicinity of the Project area (~10 miles [16 km]) examples of land use include:

- Subsistence hunting, fishing, and gathering
- Gravel pits;
- A hydroelectric plant;
- Dimension stone mining operations;
- State, county, and forest road networks;
- High voltage transmission lines;
- An airport;
- Historic and current mining features such as pit lakes and stockpiles;
- Commercial timber harvest;
- Silviculture;
- Agriculture;
- Residential (cities of Babbitt, Minnesota and Ely, Minnesota);
- Fire management; and
- Recreation.

The land within the Project area is managed for multiple uses, including mineral resource development. The Project area has a history of mineral exploration and development. In the late 1960s, the International Nickel Company, Ltd (INCO) developed a shaft in the Project area to a depth of 1,095 ft (334 m). During this same period, several other exploration companies had leases and conducted limited deeper drilling and other exploration activities in the Project area; these companies included Duval, Newmont, and Hanna. There was a break in activity and from the mid-1970s to 2005, two holes were drilled by Wallbridge Mining. Since 2006, development for exploration drilling activities has included access roads and drill pad development.

In addition to commercial and industrial uses, the region is a destination for recreation. The Project lies within the Bear Island State Forest boundary and is approximately five miles from the southwestern border of the Boundary Waters Canoe Area Wilderness (BWCAW) at the nearest point to any areas of potential ground disturbance. Additionally, the Project is outside of the state minerals management corridor adjacent to the BWCAW (Figure 4-1). The law that created the BWCAW also designated the BWCAW as a Mining Protection Area, which prohibits exploration, lease, and exploitation of minerals in the wilderness. It further extends the prohibition of mineral exploration or exploitation on property owned by the United States if that activity could materially change the wilderness characteristics of the BWCAW.

Recreational land uses typically occurring within the Project area or within 25 miles (40.2 km) of the Project area may include, but are not limited to:

- Boating, canoeing, and camping in the BWCAW and other local, state, and federal lands;
- Hunting and fishing;
- Year-round recreation, including downhill skiing, snowmobiling, off-highway vehicle (OHV) use, mountain biking, hiking, and golf;
- Recreational trails;
- Water oriented commercial businesses (e.g., resorts; houseboat rental; fish guiding; other); and
- Lake shoreland residences.

Recreation opportunities in the SNF are managed within the framework of the Recreation Opportunity Spectrum (USFS, 2004). The Project lies within a designated Roaded Natural area. This designation indicates areas where motor vehicles have full access with limited-moderate remoteness, interactions with other users may be frequent, and where human activity such as timber harvesting may be visible.

Recreation is discussed further in Section 15.1.

The Project area also falls within the boundaries of territory governed by the 1854 Treaty between the Chippewa of Lake Superior and the United States (Figure 4-2). The 1854 Treaty ceded all of the Lake Superior Chippewa lands in the Arrowhead Region of Northeastern Minnesota to the United States, in exchange for reservations for the Lake Superior Chippewa in Wisconsin, Michigan, and Minnesota.

The rights to capture or gather (or take) subsistence resources within the 1854 Ceded Territory are provided to the Bands on a usufruct basis. The concept of individuals not owning specific land, but using the resources on land controlled by larger cultural groups, represented this usufruct basis that was so important to the survival of the Ojibwe everywhere in Minnesota prior to European settlement.

As a usufructuary created by the 1854 Treaty, the Bands are allowed to use resources from land owned by others. The Project area falls within the territory ceded as part of the 1854 Treaty between the U.S. government and the Chippewa of Lake Superior. Rights for hunting and fishing under the 1854 Treaty are exercised on lands within this territory.

The Bois Forte Band of Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Fond du Lac Band of Lake Superior Chippewa (the Bands) are located within the 1854 Ceded Territory. These land uses may occur in the Project area; however, the extent of use by Band members has not been documented at this time.

Within 1.5 miles (2.5 km) of the Project area in the SNF there is the Keeley Creek Research Natural Area and a Unique Biological Area as shown on Figure 4-3. In the Project area there are no prime or unique farm lands, agricultural preserves, or conservation lands.

4.1.2 Planned Land Use

There are six land use management plans that geographically overlap with the Project area;

- Lake County Comprehensive Plan and Land Use Ordinance (Lake County, 2017);
- Lake County Local Water Management Plan (Lake County, 2012);
- St. Louis County Comprehensive Land Use Plan (St. Louis County, 2019);
- St. Louis County Comprehensive Water Management Plan (St. Louis County, 2010);
- City of Babbitt Comprehensive Plan (Arrowhead Regional Development Commission [ARDC] Regional Planning Division, 2014);
- SNF Land and Resource Management Plan (USFS, 2004); and
- Northern Superior Uplands Section Forest Resource Management Plan (MDNR, 2015a Draft).

While comprehensive plans are not regulatory decision standards, these plans do provide a vision for land management within each respective location and have been developed through collaboration between the primary governing body (Lake County, St. Louis County, Babbitt, or USFS), other applicable governmental bodies, local constituents, and other interested parties. The comprehensive plans do provide a framework for decisions reflected in other regulatory contexts, such as zoning ordinances and forest management. A comprehensive map of local zoning and management areas can be found on Figure 4-3. Figure 4-4 shows private parcels of land within Lake and St. Louis Counties subject to local land or water management plans. Additionally, Figure 4-4 identifies the nearest residences, which are associated with the South Kawishiwi Association (SKA) located to the north and west of the Project. These residences are the nearest sensitive receptors to the Project. Figure 4-5 shows federal parcels of land subject to the SNF Land and Resource Management Plan.

4.1.2.1 Lake County Comprehensive Plan and Land Use Ordinance

Private parcels of land associated with the plant site, water intake corridor, ventilation raise site 1, and portions of the transmission corridor within Lake County would be subject to the Lake County Comprehensive Plan and Land Use Ordinance. The primary purpose of the plan is to provide a vision statement for Lake County and to "promote the health, safety, and general welfare of the Lake County community." The plan identifies goals under various subject topics (i.e., housing, transportation, recreation, etc.) that act as a guide for achieving the vision the document lays out. Development plans created to achieve these goals are governed by five principles:

- Establish a land use program based upon public involvement that takes into consideration the values, traditions, customs, and well-being of county residents, using locally accepted principles of land management;
- Recognize and respect the rights of property owners;
- Base resource management strategies on sound scientific data using the best available techniques;
- Demand equal footing with all levels of government in all matters affecting Lake County; and
- Accept this Comprehensive Plan with its goals and strategies as intended to accommodate and address future growth and service demands.

The plan provides the general goals as follows:

General Goal 1: Continue to develop Comprehensive Plan to guide decision-makers that considers the values, traditions, and customs of County residents, utilizing locally accepted comprehensive planning principles.

General Goal 2: Assure a balance between development and quality of life considerations.

The plan provides specific land use goal as follows:

Land Use Goal: Support growth that is orderly and planned.

- Support the development of industry within established communities with adequate infrastructure (with the exception of natural resource-based industries);
- Support the development of non-recreationally based commercial enterprises within communities with established infrastructure and clustered in areas with adequate infrastructure;
- Minimize the impacts of land disturbing activities, on natural features, relative to erosion, stormwater runoff, wetlands, and scenic views;
    - Develop tools to preserve green space in an effort to prevent sprawl.
- Encourage development that protects the integrity of ridgelines;
    - Inventory and identify ridges holding visual and environmental importance to Lake County;
    - Develop standards for vegetative clearing, building height, screening, and building color for development on ridges holding visual and environmental importance to Lake County;
    - Encourage densities to remain low on ridges holding visual and environmental importance to Lake County.
- Minimize land use conflicts between industrial, commercial, and residential areas;
- Consider establishing buffer zones between conflicting uses.
- Evaluate and strengthen the land use education and enforcement processes;

- Secure adequate legal counsel; and
- Consider licensing / bonding any earth-moving contractors operating in Lake County.

Commercial / Industrial Development Goal 1: Maintain a favorable climate for business activity and support the development of a strong and balanced economic base.

- Support existing Lake County businesses;
- Encourage commercial and industrial development and redevelopment;
  - Participate in state and federal legislative processes related to economic development issues;
- Support the multiple-use of public lands and recognize the importance of resource-based industry;
  - Actively participate in resource management in the Lake County planning process; and
  - Work with the state to emphasize the income producing requirements of School Trust Lands in its control;

4.1.2.2 Lake County, Minnesota, Local Water Management Plan

Private parcels of land associated with the plant site, water intake corridor, ventilation raise site 1, and portions of the transmission corridor within Lake County would be subject to Lake County's Local Water Management Plan. The plan was created to "maintain and improve both surface and groundwater quality and quantity through sound ecosystem management" (Lake County, 2012). The plan attempts to accomplish this goal by focusing on the following priority water concerns:

- Increased development pressures – erosion control on construction sites, road management, cumulative impacts, shoreline erosion control;
- Enforcement of existing land use laws and use of BMPs in development activities and forest management activities;
- Stormwater management;
- Wastewater management - non-conforming sewage treatment systems, surface and groundwater contamination, drinking water quality;
- Natural resources education on water / land issues;
- Lake and stream water quality, water quantity and biological integrity; and
- Supportive of total maximum daily load (TMDL) research Project efforts and would work with landowners to complete objectives and goals identified in the TMDL implementation plans (BMPs projects / education) on north shore streams.

The Lake County Water Management Plan has been approved for an extension until 2019.

4.1.2.3 St. Louis County Comprehensive Land Use Plan

Private parcels of land associated with the transmission corridor and located in St. Louis County would be subject to the St. Louis County Comprehensive Land Use Plan (St. Louis County, 2019). The county's land use plan "provides a blueprint for managing growth, development, conservation, and other land use objectives in St. Louis County." The plan is sectioned into six areas of focus; natural environment, economic development, recreation and tourism, transportation, public safety, and land use. Goals, objectives, and implementation plans are then developed for each area of focus. The implementation plans are then ranked and tracked to provide a long-term vision for managing land use within St. Louis County.

Chapter 2 of the St. Louis County Comprehensive Land Use Plan provides insight into the county's land use goals with respect to economic development. The chapter specifically addresses mining and defines mining impact areas within the county in a three-tier system:

- Tier 1 encompasses the actively mined iron formation;
- Tier 2 includes areas of more active non-ferrous exploration and mineral lease activity in the Duluth Complex. It encompasses the general co-location of exploratory borings, active mineral leases, and known mineral prospects; and
- Tier 3 extends beyond the mining formations to include ancillary uses, such as tailings basins.

The plan identifies the location of the Project area in St. Louis County as Tier 2. The plan further supports mining within these tiers by indicating that "the county will proceed cautiously with permitting of uses that are not related to mining, especially within Tiers 1 and 2. This discretion is needed to preserve opportunities for mining industry growth, to mitigate environmental hazards, and to avoid potential land use conflicts before they begin. This approach is intended to provide clarity to all current and future owners of land and minerals within the mining impact areas."

4.1.2.4 St. Louis County Comprehensive Water Management Plan

Private parcels of land associated with the transmission corridor and located in St. Louis County would be subject to the St. Louis County Comprehensive Water Management Plan. The county's water management plan "provides strategy to address the water-related issues in St. Louis County." The plan recognizes the following priorities:

- Identify existing and potential problems facing the county's water resources;
- Identify opportunities to protect those water resources;
- Identify goals and objectives to manage the county waters and their related land uses in ways that promote sound, hydrologic, and efficient management and effective environmental protection of those water resources; and
- Devise and carry out a plan of action that achieves the stated goals and objectives related to managing the county's water resources.

The plan identifies four primary areas of concern related to water management within St. Louis County including negative impacts from development, pollution resulting from inadequate wastewater management, pollution to surface and groundwaters from contaminated runoff and impaired water management. The primary area of concern most associated with the Project would be the potential negative impacts from development. The plan identifies action items associated with this concern that are centered around the proper management of stormwater. The implementation of BMPs for construction stormwater control are emphasized.

4.1.2.5 City of Babbitt Comprehensive Plan

Several private parcels of land associated with the transmission corridor and off-site electrical substation would be subject to the City of Babbitt Comprehensive Plan. This plan is intended to, "set policies for efficient land use and allocate land among industry, commerce, residences, public facilities, parks and recreation spaces, open and natural spaces, and other public and private uses." The land use goals outlined by the City of Babbitt Comprehensive Plan are as follows:

- Support the compact, efficient, and orderly growth of all urban development including residential, commercial, and industrial areas;
- Have adequate amounts of land properly zoned, with infrastructure, to meet demand for development within the city;
- Strengthen the distinction between the developed and developing parts of the city;
- Provide and maintain adequate community parks and open space to meet the future needs of the community;
- Enhance the community's character and identity; and
- Maintain a modern, up-to-date zoning ordinance, zoning map, official map, and permitting documents.

The City of Babbitt Comprehensive Plan identifies mining as, "integrally linked to the history of the community" and makes the following note regarding mining, timber, and tourism:

"While related objectives are established in the economic development and land use chapters of the plan, these industries are so critical that specific goals and objectives have been outlined during the planning process to continue to build Babbitt's future economically."

One of the specific goals outlined in the plan is to support non-ferrous mining projects in and around Babbitt.

4.1.2.6 Superior National Forest Land and Resource Management Plan

Portions of the plant site, tailings management site, ventilation access roads, access road, and transmission corridor located on federally owned land would be subject to the SNF Land and Resource Management Plan. The purpose of the plan is to "guide all natural resource management activities for the SNF." The plan provides direction, goals, and implementation guidance intended to influence day-to-day management and long-term management of the SNF. Fundamental principles guiding this management strategy include:

- The USFS will follow laws and regulations as well as policies in the USFS Manuals and Handbooks that relate to managing National Forest System land;
- The USFS will coordinate management activities with the appropriate local, state, or Tribal governments as well as with other federal agencies;
- The USFS will actively consult with Tribal governments and collaborate with interested organizations, groups, and individuals; and
- The USFS will manage the SNF for multiple uses.

The SNF is broken out by management areas which are assigned desired conditions, objectives, standards, and guidelines. Most of the Project area is in General Forest management areas with portions near Birch Lake identified as Recreation Use in a Scenic Landscape management areas.

General Forest Management Areas

General Forest management areas “emphasize land and resource conditions that provide a wide variety of goods, uses, and services” (USFS, 2004). These management areas are the most common in the SNF, may have buildings and structures to support resource management objectives, and most special uses can be accommodated.

Recreation Use in a Scenic Landscape

“Recreation Use in a Scenic Landscape management area emphasizes land and resource conditions that provide a scenic landscape for recreational activities in natural-appearing surroundings” (USFS, 2004). Developed facilities and access may result in concentrated recreation and a high degree of user interaction. The management areas may have buildings and structures to support resource management objectives and most special uses can be accommodated.

4.1.2.7 Northern Superior Uplands Section Forest Resource Management Plan

The Project would be located within the Bear Island State Forest, which is managed by the MDNR. Previously, this area was managed as three separate sections: Border Lakes, North Shore Area, and a portion of North 4. Currently, the forestry management plan for this area is being revised to consolidate these three areas into one area known as the Northern Superior Uplands (NSU). The Northern Superior Uplands Section Forest Resource Management Plan is in the process of being drafted with an anticipated completion in the near future. The state forest management units within the Project area would be subject to the Northern Superior Uplands Section Forest Resource Management Plan.

4.1.3 Current Zoning and Management Codes

There are four zoning authorities associated with the Project area; Lake County, MDNR, St. Louis County, and Babbitt. Local zoning controls apply to the portions of the Project area within private ownership. Federal lands are not subject to local zoning controls but are governed by federal rules and regulations. State lands are not subject to local zoning controls but may require compliance with all applicable municipal, county and state laws, ordinances and regulations, and obtaining and paying for all leases, licenses, easements and permits as may be required by its use. A comprehensive map of local zoning districts applicable to the Project area are illustrated on Figure 4-3. This figure also identifies the Shoreland Zoning areas surrounding water basins (Birch Lake) and water courses (Keeley Creek, Denley Creek, and Stony River) within the Project area subject to additional shoreland zoning requirements. Figure 4-4 identifies parcels of land within the Project area subject to local zoning (Lake County, St. Louis County, and Babbitt).

4.1.3.1 Lake County

<u>Forest and Recreation (FR)</u>

Most private parcels associated with the plant site, or transmission corridor within Lake County would be located on land zoned as FR. According to the Lake County zoning ordinance, the FR district:

> "provides for remote residential development distant from public services, prevents destruction of natural or man-made resources, maintains large tracts for forest recreation purposes, provides for the continuation of forest management and production programs, and fosters certain recreational uses and other activities which are not incompatible with the public welfare" (Lake County, 2017)

Permitted uses for this zoning district include:

- Single-family dwellings;
- Forest management and utilization;
- Soil and water conservation programs;
- Wildlife preserves;
- Tree plantations;
- Home occupations;
- Compatible recreational uses;
- Farms and commercial livestock;
- Portable sawmills;
- Customary accessory structures and uses; and
- Vacation rental home.

Interim uses for this type of zoning include:

- Aggregate pits.

Prohibited uses for this type of zoning include:

- Uses requiring urban level public services.

A Conditional Use Permit is required for any use not listed as permitted, interim or prohibited.

Residential Recreation (RR)

A portion of the water intake corridor and ventilation raise site 1 would be located on private land zoned RR. According to the Lake County zoning ordinance the RR district:

> "provides for residential development and essential recreation-oriented services in areas of high recreational value where soil conditions and other physical features will support such development without depleting or destroying natural resources"

Permitted uses for this zoning district include:

- Single-family dwellings;
- Home occupations; and
- Customary accessory structures and uses.

Interim uses for this type of zoning include:

- Vacation rental home.

Prohibited uses for this type of zoning include:

- Commercial agriculture, kennels, aggregate pits.

A Conditional Use Permit is required for any use not listed as permitted, interim, or prohibited.

Shoreland Zoning Provisions

Article 7.0, Shoreland Zoning Provisions, of the Lake County Zoning Ordinances defines the shoreland boundary as land within 1,000 ft (304.8 m) of the ordinary high water level elevation of public water basins (Birch Lake) and within 300 ft (91.4 m) of the ordinary high water level elevation of public watercourses (Keeley Creek, Denley Creek, Stony River, and Unnamed Stream [Kittle Number H-001-092-015]). Structures within the shoreland of Birch Lake are required to be set back more than 100 ft (30.5 m) from the ordinary high water level elevation or require vegetative screening. Keeley Creek, Denley Creek, Stony River, and Unnamed Stream are watercourses with special shoreland classifications. Structures developed within the shoreland of these water courses are required to be setback 100 ft (30.5 m) from the ordinary high water level elevation. Structures within shoreland zoning are subject to certain requirements including placement, design, height, and vegetative standards. Additionally, shoreland zoning provisions also describe requirements for shoreland alteration, shoreland excavations, and road locations. Parts of the Project that are within shoreland zoning include portions of the:

- Tailings management site;
- Transmission corridor;
- Non-contact water diversion area;
- Ventilation raise sites;

- Plant site; and
- Water intake corridor.

4.1.3.2 MDNR

The MDNR is responsible for developing Minn. R., chapter 6120, which set the minimum standards for shoreland management for public water basins and watercourses. On private lands these standards are implemented through local shoreland ordinances and administered by the local zoning authority. However, on state lands the MDNR administers the shoreland rules directly. Within the Project area, Minnesota School Trust Lands where Keeley Creek is located would have shoreland administered by the MDNR. The administrative rules identify that structures developed within 300 ft of the ordinary high water level elevation of watercourses identified as urban or tributary (Keeley Creek), are required to be set back 100 ft for unsewered developments.

4.1.3.3 St. Louis County

Uses associated with the Project, are defined within the St. Louis County zoning ordinance (St. Louis County, 2016) as follows:

- Utility Facilities – Class I – A category of uses that includes, but is not limited to: electrical lines, fuel tanks, ham radio towers, outdoor wood boilers, small collector wastewater treatment plants, solar panel battery or storage stations for private residential use, and wind turbines for private residential use; and
- Utility Facilities – Class II – A category of uses that includes, but is not limited to electrical substations, communication towers, and wastewater treatment plants (municipal or sanitary districts).

Forest Agricultural Management District (FAM)

A portion of the transmission corridor crosses the FAM district within St. Louis County. According to the St. Louis County zoning ordinance, the FAM district is intended to:

> "promote the development of the country's forestry and agricultural industry and encourage recreational use of such areas. This district is typically used in areas with land developed at very low densities and often there is considerable government and corporate ownership. A low level of development is important in areas where this district is used since the uses encouraged in this district would be less compatible in a more urban setting" (St. Louis County, 2016)

Uses allowed without a permit for this zoning district include:

- Agricultural Use – Class I, II
- Utility Facilities – Class I

Uses allowed that require a permit within this zoning district include:

- Residential
- Outdoor Signs
- Extractive Use – Class I, II
- Industrial Use – Class I, II, III
- Transportation – Class I, II
- Utility Facilities – Class II, III
- Commercial Retail and Service Establishments – Class I, II, III
- Mineral Exploration and Evaluation
- Planned Development – Class I
- Public / Semi-public Use
- Recreational Use – Class I, II

Prohibited uses within this zoning district include:

- Planned development – Class II

A Conditional Use Permit is required for Utility Facilities – Class II use.

Residential (RES)

A portion of the transmission corridor crosses the RES district within St. Louis County. According to the St. Louis County zoning ordinance, parcels within the RES district are:

> "intended to be used in those areas of the county with extensive or the potential for extensive residential development. This district shall be used to promote a high quality residential living environment where non-residential uses are restricted. This district may be used in shoreland and nonshoreland areas that are typically platted, or, in not platted, have a development density of dwellings of more than one dwelling per 300 lineal feet of lot frontage"

Uses allowed without a permit for this zoning district include:

- Agricultural Use – Class I
- Utility Facilities – Class I

Uses allowed that require a permit within this zoning district include:

- Residential Use
- Outdoor Signs
- Agricultural Use – Class II
- Extractive Use – Class I
- Industrial Use – Class I
- Utility Facility – Class II
- Commercial, Retail, and Service Establishments – Class I
- Mineral Exploration and Evaluation
- Planned Development – Class I

- Public / Semi-public Use
- Transportation – Class I, II

Uses prohibited within this zoning district include:

- Commercial, Retail, and Service Establishments – Class II, III
- Extractive Use – Class II
- Planned Development Class II
- Industrial Use – Class II, III
- Recreational Use – Class I, II
- Utility Facilities – Class III

A Performance Standard Permit is required for Utility Facilities – Class II use.

Industrial (IND)

A portion of the transmission corridor crosses the IND district within St. Louis County. According to the St. Louis County zoning ordinance, parcels within the IND district are:

> "intended to encourage the development of heavy industry in the county by providing appropriate locations for such activities. The district should always be located in an area and manner which will ensure the most effective and beneficial impact to the county. This district shall not be used in any shoreland district"

Uses allowed without a permit for this zoning district include:

- Agricultural Use – Class I, II
- Industrial Use – Class III
- Mineral Exploration and Evaluation

Uses allowed that require a permit within this zoning district include:

- Outdoor Signs
- Extractive Use – Class I, II
- Transportation – Class I
- Industrial Use – Class I, II
- Utility Facilities – Class I, II, III

Uses prohibited within this zoning district include:

- Commercial, Retail, and Service Establishments – Class I, II, III
- Planned Development – Class I, II
- Public / Semi-public Use
- Recreational Use – Class I, II
- Transportation – Class II
- Recreational Use

A Conditional Use Permit is required for Utility Facilities – Class I and Utility Facilities – Class II use.

4.1.3.4 *Babbitt*

Mineral Mining District (MM)

A portion of the transmission corridor crosses the MM district within the city limits of Babbitt. According to the Babbitt zoning ordinances, parcels within the MM district are:

> "areas of existing and potential mineral mining, processing, storage and loading, tailings and waste disposal, and accessory and support activities required for proper operation of mining activities located outside of the limits of the open pit and ore formation and to assure the compatibility of these uses to other uses within the city of Babbitt" (City of Babbitt, 1996)

Permitted uses within this zoning district include:

- Forestry;
- Mineral mining and any ancillary activities necessary for management; and
- Operation and uses involved in the mineral extraction, processing transportation and disposal of waste as regulated by Minnesota.

There are no uses listed as requiring a Conditional Use Permit for the MM district within Babbitt; however, all mineral mining activity is required to conform to Minnesota regulations. Additionally, no prohibited uses are listed.

4.1.3.5 *1854 Treaty Area Management*

1854 Treaty Authority

The 1854 Treaty Authority is an Inter-tribal Natural Resources Management Organization that manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of Lake Superior Chippewa in the territory under legal agreement with the State of Minnesota. The 1854 Treaty Authority's mission statement is to "provide an Inter-Tribal natural resource program to ensure that the rights secured to member Native American tribes by treaties of the United States to hunt, fish, and gather within the 1854 Ceded Territory shall be protected, preserved and enhanced for the benefit of present and future member Native American tribes in a manner consistent with the character of such rights, through provisions of services." The 1854 Treaty Authority's management of natural resources generally focuses on some of the most commonly hunted, fished, or gathered natural resources.

The 1854 Treaty Authority has adopted the Ceded Territory Conservation Code (2018). The Ordinance governs the Ceded Territory's "hunting, fishing, trapping and gathering activities of resources for subsistence use," subject to the provisions of this ordinance by Band Members within the Ceded Territory. The purpose of the Ordinance is:

- to provide an orderly system for 1854 Treaty Authority control and regulation of hunting, fishing, trapping, and gathering of resources for subsistence use in the Ceded Territory; and,
- to provide a means to promote public health and safety; and the conservation and management of fish, wildlife, and plant populations in the Ceded Territory through the regulation of Band Member harvesting activities.

Fond du Lac Band of Lake Superior Chippewa

Governance of hunting, fishing, trapping, management, and gathering of natural resources by the Fond du Lac Band of Lake Superior Chippewa within the 1854 Ceded Territory is demonstrated in the Fond du Lac Ceded Territory Conservation Code. The purpose of the Code is to provide a system for tribal control and regulation of hunting, fishing, and gathering within the Ceded Territory, provide a means to promote public health and safety through the conservation and management of natural resources within the Ceded Territory, and to promote and protect the rights of the Fond du Lac retained under the 1854 Treaty.

The Fond du Lac Band of Lake Superior Chippewa has adopted a Ceded Territory Conservation Code (as amended). The purpose of the Code is to provide:

- an orderly system for tribal control and regulation of hunting, fishing, gathering, trapping and resources management in the 1854 ceded territory;
- provide a means to promote public health and safety and the conservation and management of fish, wildlife, natural resources, and plant populations in the Ceded Territory through the regulation of Band Member harvesting activities; and
- to the fullest extent possible, to promote and protect the rights of the Fond du Lac Band of Lake Superior Chippewa retained under the 1854 Treaty

4.2 Project Impacts

4.2.1 Planned Land Use

The Project would be compatible with planned land uses identified by Lake County, St. Louis County, Babbitt, and the USFS. All plans acknowledge the importance of responsible management of resource extraction.

Any potential effects to recreation will be studied as outlined in Section 15.1.

4.2.1.1 Lake County Comprehensive Plan and Land Use Ordinance

The Project would be compatible with the Lake County Comprehensive Plan and Land Use Ordinance. Principle 1 of the plan lists “logging and mining” as one of the “definitive values, traditions, and customs.” Additionally, the Project would be in alignment with land use goals and the primary commercial / industrial use goal outlined within the plan.

4.2.1.2 Lake County, Minnesota, Local Water Management Plan

The Project would be compatible with the Lake County Local Water Management Plan. This plan identifies six high priority watersheds, including the Kawishiwi Watershed. The Project area lies within the Kawishiwi Watershed which is made up of the following U.S. Geological Survey (USGS) Hydrological Unit Code (HUC)-10 watersheds:

- Kawishiwi River,
- Isabella River,
- Stony River,
- Birch Lake, and
- portions of Fall Lake.

From the Kawishiwi Watershed Protection Project Implementation Plan (Wenck Associates, Inc., 2013) the priority management areas are:

- Enforce shoreland management regulations as property develops and redevelops, and encourage voluntary actions to mitigate the impacts of past development.
- Proactively protect beneficial uses by taking positive actions to halt or minimize the spread of Aquatic Invasive Species.
- Protect and improve water quality by reducing the number of noncompliant Subsurface Treatment Systems and increase the number of Subsurface Treatment Systems that are properly operated and maintained.
- Protect and improve water quality and aquatic and terrestrial habitat by implementing shoreland Best Management Practices to stabilize and restore eroding shoreline and establish native shoreline and emergent vegetation.
- Continue to monitor water quality and evaluate water quality trends.
- Coordinate education and outreach messages and delivery methods with and between federal and state agencies, county and local governments, lake associations and other groups.

The Project would be compatible with these priority management areas and their underlying objectives.

The plan also identifies stormwater management as one of the priority concerns established by the Water Plan Advisory Committee; the Project would implement a Stormwater Pollution Prevention Plan to mitigate stormwater impacts during construction and operation.

4.2.1.3 St. Louis County Comprehensive Land Use Plan

Development of a portion of the transmission corridor within St. Louis County would be compatible with the St. Louis County Land Use Plan. Specifically, the Project meets the goals outlined within the economic development portion of the plan. The Project would be within the mining impact area Tier II, where the development of infrastructure to support mining operations is encouraged. The plan also identifies the development of additional utility coverage within St. Louis County as a goal, which is in direct alignment with the development that would be associated with the Project.

4.2.1.4 *St. Louis County Comprehensive Water Management Plan*

Development of a portion of the transmission corridor within St. Louis County is compatible with the St. Louis County Comprehensive Water Management Plan. Construction of this corridor would be completed using construction stormwater BMPs that may include, but would not be limited to, standard practices such as the implementation of silt fencing, sediment logs, and re-vegetation of disturbed surfaces as soon as practicable. These development BMPs are compatible with the St. Louis County's Comprehensive Water Management Plan.

4.2.1.5 *City of Babbitt Comprehensive Plan*

Development of a portion of the transmission corridor and the off-site electrical substation within the limits of Babbitt is compatible with the City of Babbitt Comprehensive Plan. The plan states that the mining industry is critical to Babbitt's economic future specifically lists the support of non-ferrous mining as a goal.

4.2.1.6 *Superior National Forest Land and Resource Management Plan*

The SNF Land and Resource Management Plan identifies mineral development as a desired condition in the Project area and applies two desired conditions to this resource:

- "Exploration and development of mineral and mineral material resources is allowed on National Forest System land, except for federally owned minerals in designated wilderness (BWCAW) and the Mining Protection Area; and
- Ensure that exploring, developing, and producing mineral resources are conducted in an environmentally sound manner so that they may contribute to economic growth and national defense."

Additionally, most of the Project area is identified as General Forest, where the development of mineral resources is identified as an allowable resource management practice. Portions of the plant site, water intake corridor, and transmission corridor may cross SNF lands identified as Recreation Use in Scenic Landscape, where development of mineral resources and structures including power lines and pipelines are an acceptable development.

Given that the Project meets the two desired conditions, as well as the land uses allowable by the plan, the Project would be compatible with the SNF Land and Resource Management Plan.

4.2.1.7 *Northern Superior Uplands Section Forest Resource Management Plan*

As identified in Section 4.2.1, the Northern Superior Uplands Section Forest Resource Management Plan is currently being drafted with an anticipated completion date of 2019. Initial draft sections of this document available on the MDNR website indicate that mining would be an acceptable use within the state forest. Specifically, within the draft introduction to the new management plan, the MDNR identifies that, "Logging, forest management, tourism, recreation, and mining are important industries." It is anticipated that the Project would be compatible with the Northern Superior Uplands Section Resource Management Plan.

4.2.1.8 *Land Use Impacts Summary*

The available information is adequate to make a reasoned decision about Project's compatibility with the land use plans reviewed in this section. Based on this review, there are no potential significant effects identified and the topic is considered minor.

4.2.2 Zoning and Management Codes

The Project would likely require conditional use permitting in Lake County and St. Louis County and would be compatible with the underlying zoning.

4.2.2.1 *Lake County*

The plant site, water intake corridor, ventilation raise sites and access road, and transmission corridor are acceptable uses in the zoning districts with which they are associated (FR and RR in Lake County but would require local permitting). The Project would not effect the zoning designation for SKA residences.

Additionally, the water intake facility, portions of the tailings management facility, and portions of the transmission corridor would be required to abide by setback requirements for Birch Lake, Keeley Creek, Denley Creek, and Stony River, identified by Lake County Shoreland Zoning Ordinances.

The Project would be compatible with Lake County zoning.

4.2.2.2 *MDNR*

Most of the tailings management site would be outside of the shoreland boundary. The tailings management site would adhere to the shoreland setback requirements identified by Minnesota's Administrative Rules. The Project would be compatible with the statewide minimum shoreland standards.

4.2.2.3 *St. Louis County*

The transmission corridor is listed as an acceptable use in all three zoning districts it crosses in St. Louis County (FAM, RES, and IND) but would require local permitting.

A portion of the transmission corridor would be required to adhere to St. Louis County's Shore Impact Zone requirements for Birch Lake, as well as an unnamed stream that feeds Birch Lake.

The Project would be compatible with St. Louis County zoning.

4.2.2.4 *Babbitt*

The transmission corridor is a permitted use within Babbitt's MM district. No impacts or additional permitting are anticipated for land use within Babbitt.

4.2.2.5 1854 Treaty Area Management

Within the entire 1854 Treaty Territory, there are approximately 2.9 million acres of tribal and public lands. The tribal and public lands provide access to Band members exercising usufructuary rights to hunt, fish, and gather plants within the 1854 Ceded Territory. The Project would restrict access on approximately 800 acres of public lands due to the presence of Project facilities or fences. The change in accessibility represents a 0.03% reduction in total acreage within the 1854 Treaty Territory. These land uses may occur in the Project area; however, the extent of use by Band members has not been documented at this time.

4.2.2.6 Zoning Impacts Summary

The available information is adequate to make a reasoned decision about Project's compatibility with the zoning ordinances reviewed in this section. The Project would follow the applicable zoning ordinances. Based on this review, there are no potential significant effects identified and the topic is considered minor.

4.3 Future Scope

Existing use by Band members on lands within the Project area has not been documented. In order to better understand the extent of use by Band members, TMM will work with the lead agencies and with the affected Bands to better understand historic, as well as present day subsistence uses, by Band members.

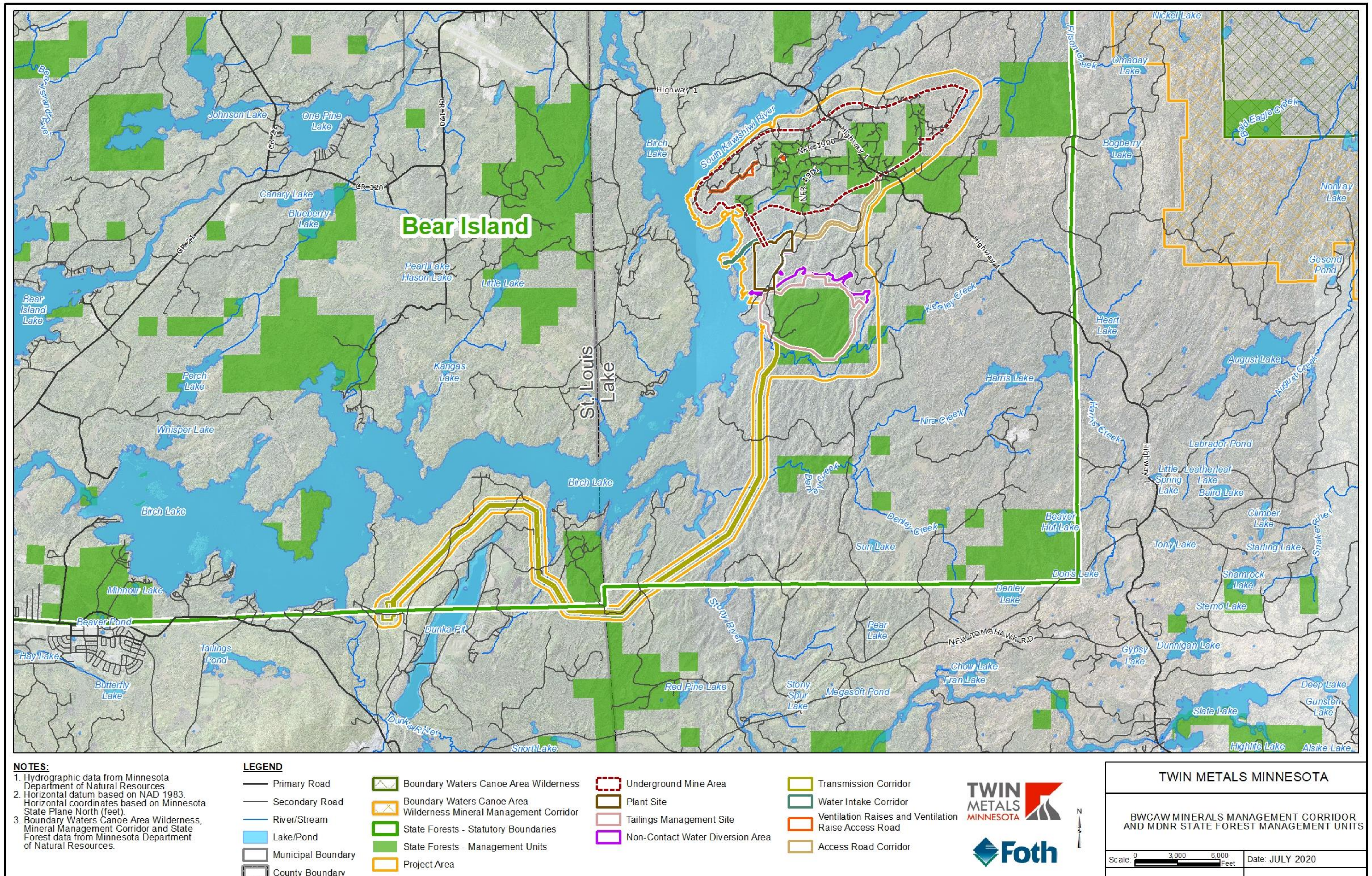
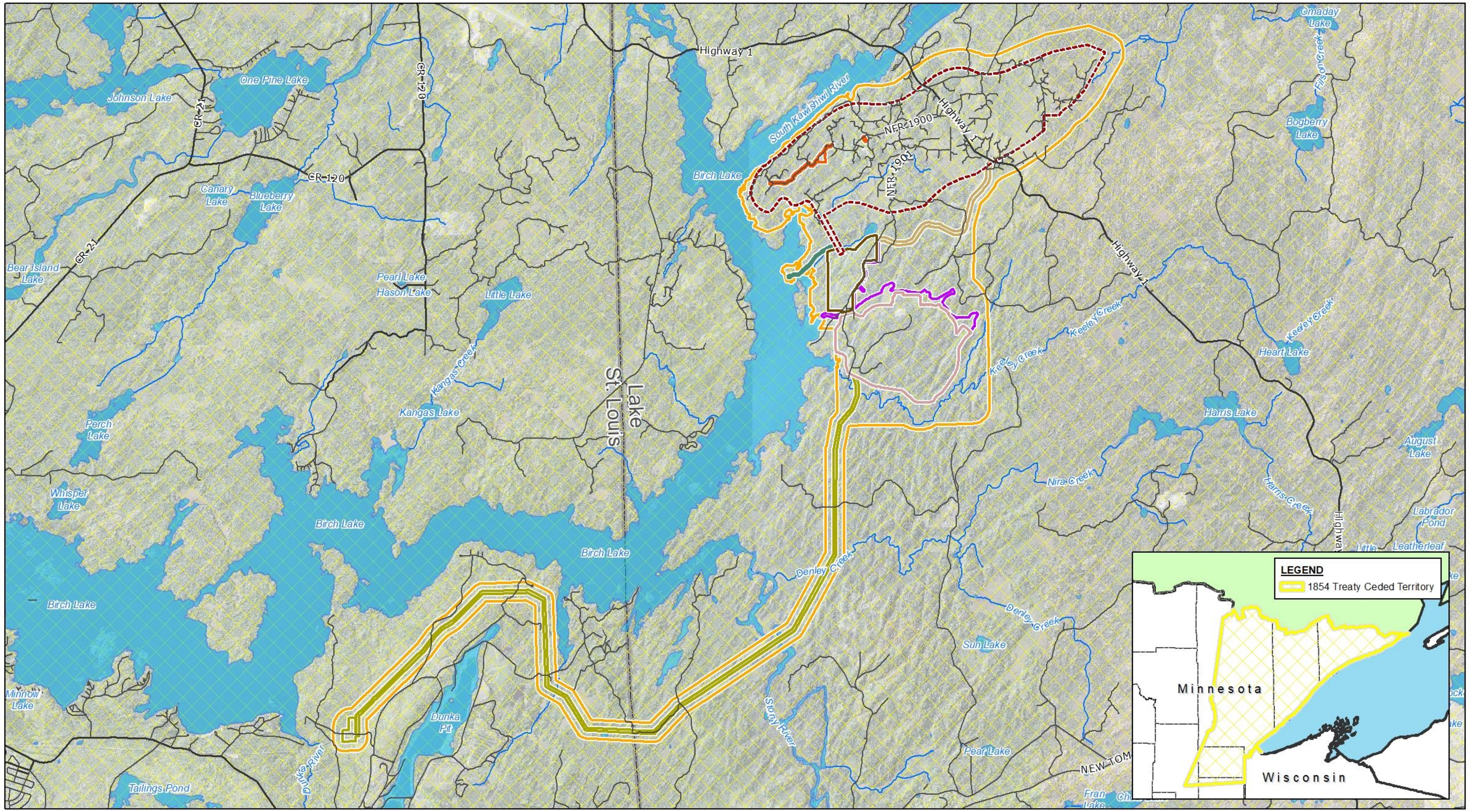


Figure 4-1 BWCAW Minerals Management Corridor and MDNR State Forest Management Units



NOTES:
1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. 1854 Treaty Ceded Territory data from The Great Lakes Indian and Wildlife Commision.

LEGEND
- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- 1854 Treaty Ceded Territory
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

1854 TREATY CEDED TERRITORY

Scale: 0 2,500 5,000 Feet | Date: JULY 2020

Figure 4-2 1854 Treaty Ceded Territory

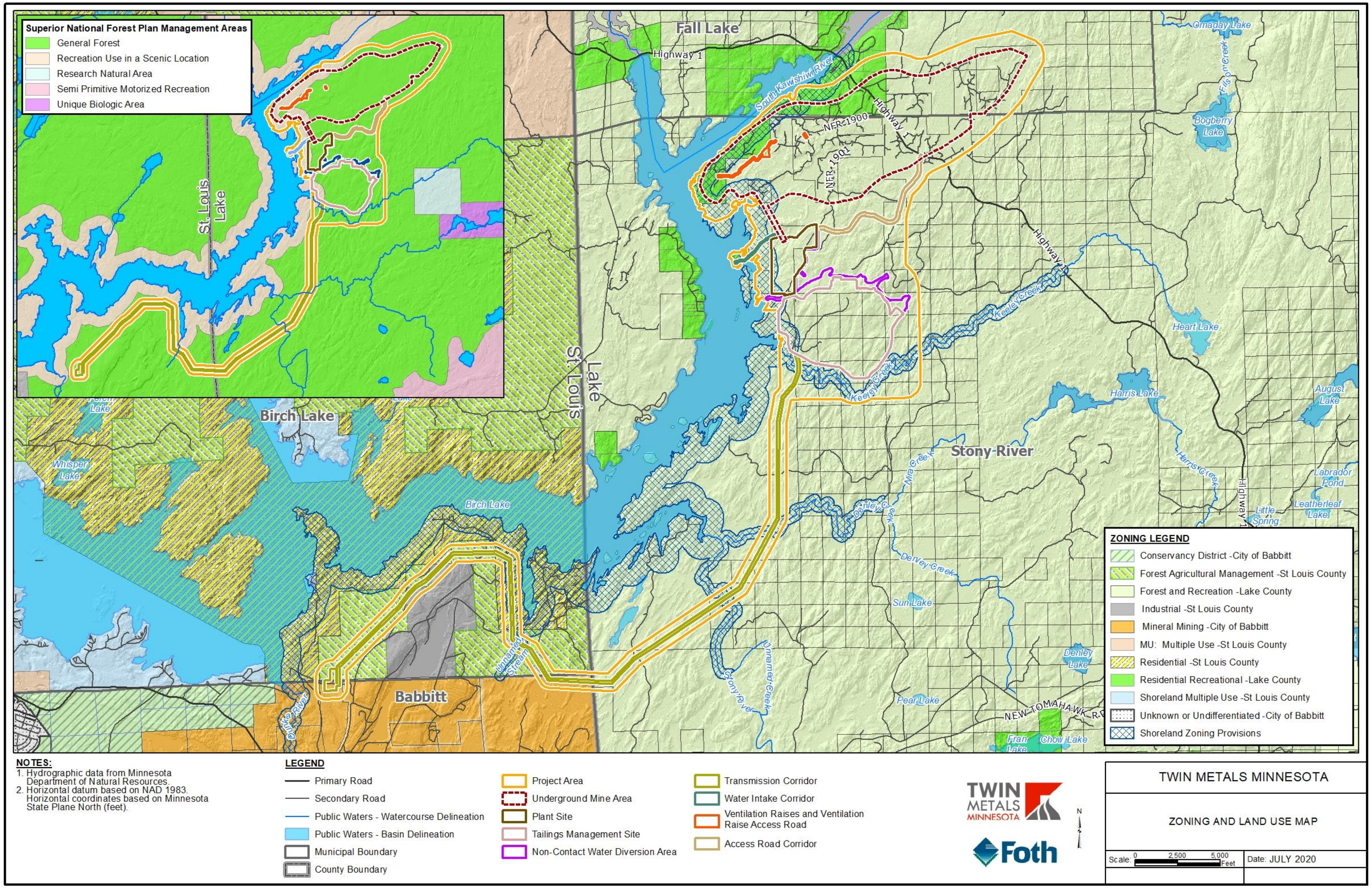


Figure 4-3 Zoning and Land Use Map

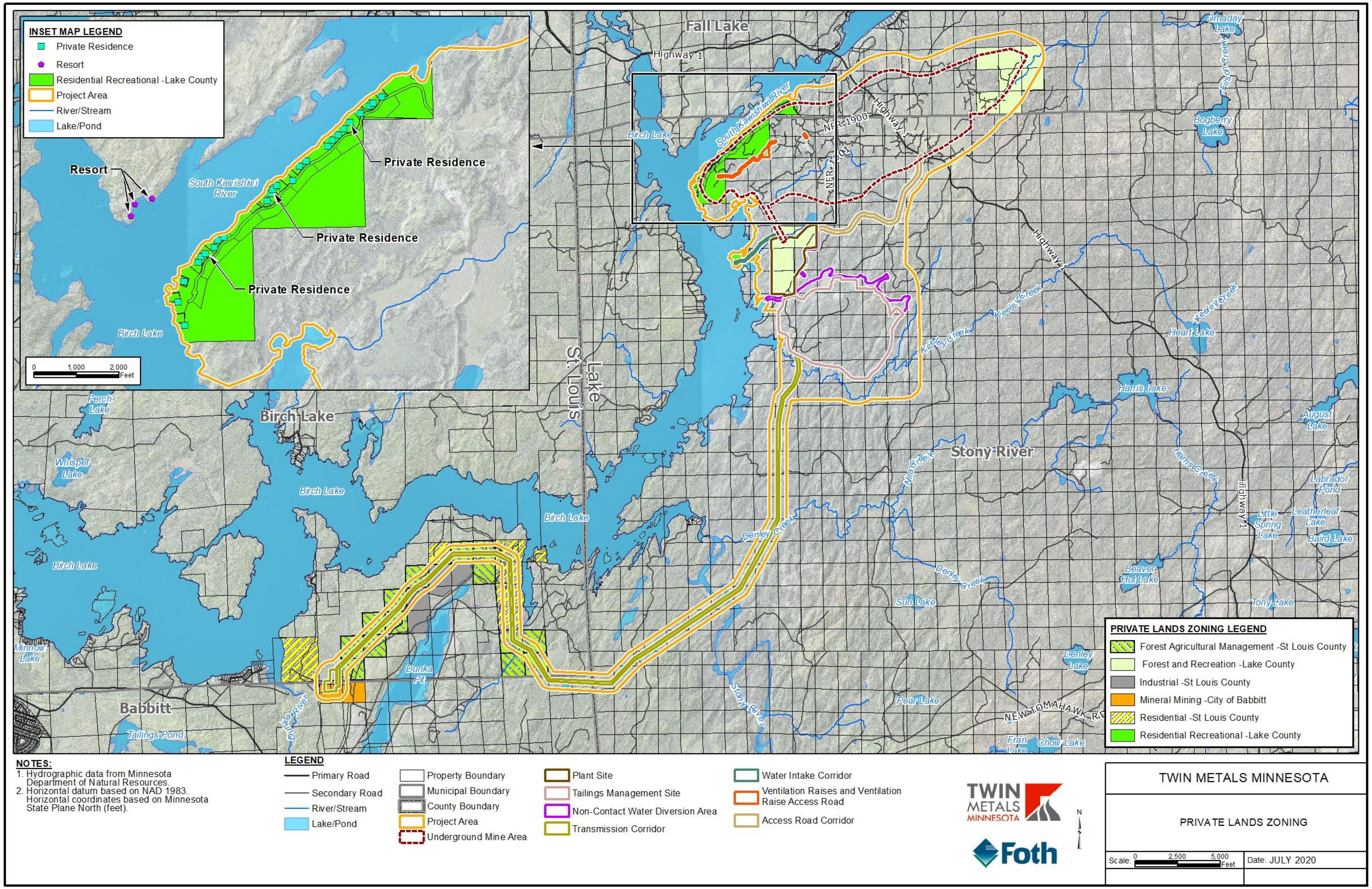


Figure 4-4 Private Lands Zoning

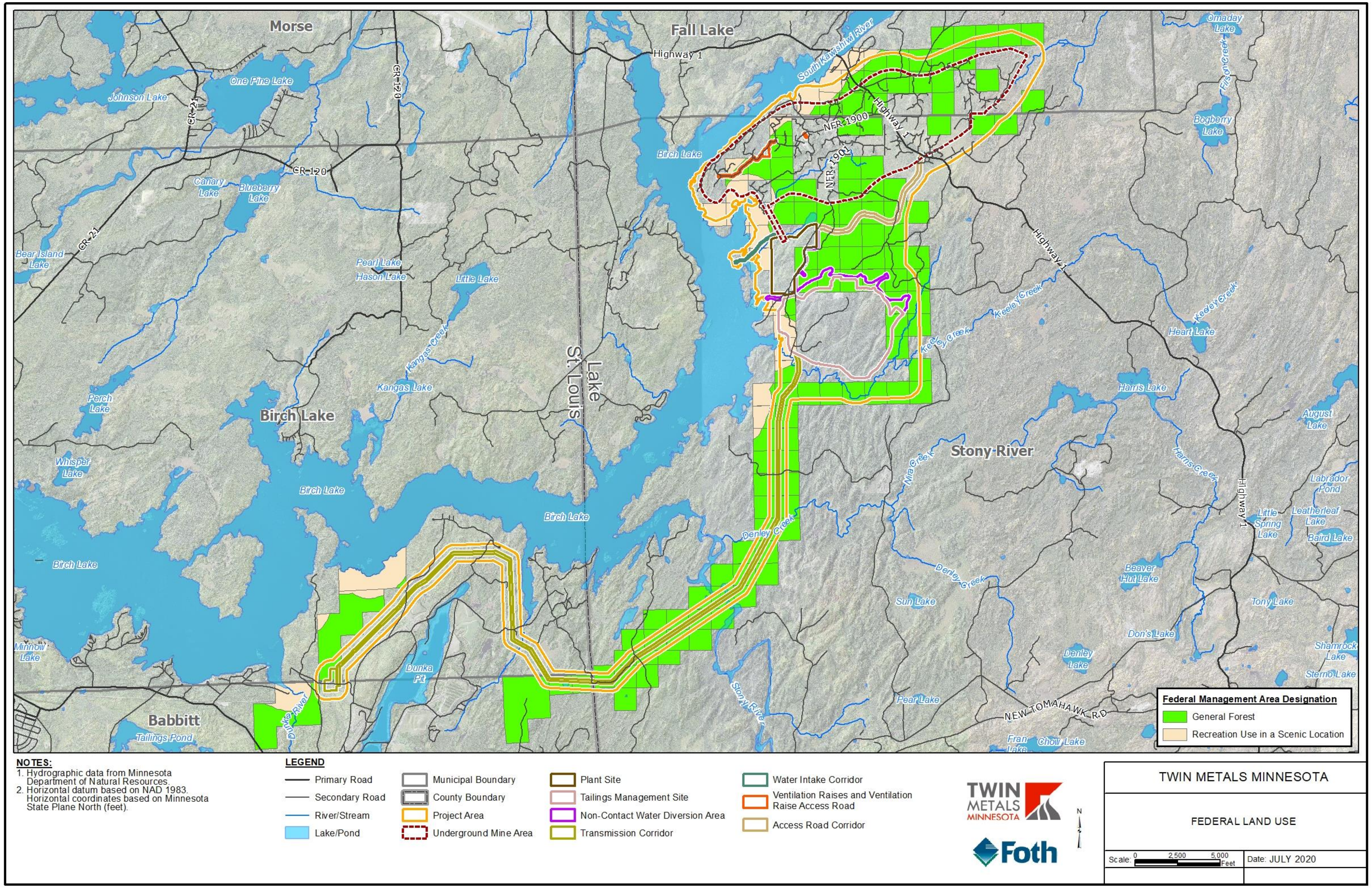


Figure 4-5 Federal Land Use

5.0 GEOLOGY, SOILS, AND TOPOGRAPHY / LAND FORMS

5.1 Baseline Conditions

5.1.1 Geology

The Project area is underlain by the Duluth Complex which is composed of igneous rocks associated with the Midcontinent Rift System. The Midcontinent Rift System occurred approximately 1.1 billion years ago and is traceable from the east side of Michigan, arcing west across the Lake Superior basin, and extending south-southwest to northeastern Kansas. The thinning of the earth's crust (rifting) that resulted from tectonic extension allowed for large layered igneous intrusions and vulcanism; the largest composite of these layered intrusions is the Duluth complex, a composite intrusion of igneous rocks (troctolites to gabbros and anorthosites) derived from episodic intrusive events from an evolving magma source related to rift development. The Duluth Complex is the host of the Maturi mineral deposit shown on Figure 5-1. To the north and west of the Project area, rocks of the Superior Province of the Canadian Shield include Archaean (greater than [>] 2,600 million years old) mafic to felsic metavolcanic rocks, metasedimentary rocks, ortho- and paragneisses, and granitic intrusions; and to the southwest, Paleoproterozoic (~1,850 million years old) iron-formation, clastic, and carbonate metasedimentary rocks of the Animikie Basin.

5.1.1.1 Bedrock

The Project area would be located at the contact of two major bedrock units, the Giants Range Batholith (GRB) and the Duluth Complex.

The Duluth Complex is composed of mafic to felsic tholeiitic igneous rocks related to the Midcontinent Rift System and makes up much the bedrock of northeast Minnesota. It is bounded by a footwall of Paleoproterozoic sedimentary rocks and Archean granite-greenstone terranes and a hanging wall largely of rift-related flood basalts and hypabyssal intrusions of the Beaver Bay Complex (Miller et al., 2002).

The targeted mineralization of the Maturi deposit is hosted within the basal portion of the South Kawishiwi Intrusion (SKI), known as the BMZ. The SKI is bordered by:

- the GRB and Biwabik Iron Formation to the northwest,
- the Anorthositic Series to the northeast,
- the Partridge River Intrusion and the Western Margin Intrusion to the southwest,
- the Bald Eagle Intrusion to the east, and
- the Greenwood Lake Intrusion to the southeast.

A small portion of the southwestern extent of the SKI is bordered by the Bath Tub intrusion near Babbitt. Excluding the transmission corridor, lithologic units within the Project area include Mesoproterozoic rocks of the SKI and the Anorthositic Series of the Duluth Complex, as well as basalt xenoliths of the North Shore Volcanic Group. SKI magmas intruded sub-horizontally between hanging wall Anorthositic Series rocks and footwall granitic rocks of the GRB. Additionally, the transmission corridor portion of the Project area includes the lithologic units of the Biwabik Iron Formation and the Giants Range Granite. A brief description of the map units associated with the Project are discussed in the generalized stratigraphy of the Maturi deposit shown on Figure 5-2. A bedrock geology map of the Project area is shown on Figure 5-3 and cross sections of the deposit are shown on Figure 5-4 through Figure 5-7.

As shown in the cross sections and discussed in the geologic description, the Project area does not include shallow limestone formations and the bedrock conditions associated with the Project are not susceptible to geologic conditions such as sinkholes or karst conditions.

5.1.1.2 Surficial Geology

Surficial geology in the Project area is dominated by glacial deposits associated with the Rainy Lobe that include areas of peat and lake sediment. The Rainy Lobe Till is a brown, sandy till that contains basalt, gabbro, and other rocks. In some localities along the shoreline of Birch Lake, the Rainy Lobe Till has been eroded by water, resulting in a less rugged surface expression and a possible surface lag consisting of concentrated coarse-grained clasts. The lake sediment is predominantly silt, clay, and organic material (Jennings and Reynolds, 2005). The thickness of surficial material in the Rainy Lake Watershed is generally less than (<) 50 ft (15.6 m) and is laterally discontinuous. In the vicinity of the plant site, bedrock crops out in 5 to 20% of the area (Ericson et al., 1976).

5.1.1.3 Mineralogy

The deposit is composed of anorthositic troctolite to troctolites. The mineralogy consists primarily of plagioclase, olivine, pyroxenes, and oxides which make up more than 85% of the total mineralogy. The alteration minerals (e.g., serpentine, chlorite, etc.) typically comprise 1% to 6% of the mineralogy but are locally found in amounts up to 15%. Sulfide content of the ore-bearing geologic units ranges from 1% to 6%, with very local areas having sulfide contents outside of that range.

The main four sulfides present in the deposit include:

- Chalcopyrite;
- Cubanite;
- Pentlandite; and
- Pyrrhotite.

Other copper and nickel sulfides are present in the deposit but occur in minor amounts (<5% total sulfides).

5.1.1.4 Structure

Rock units and mineralization in the BMZ are planar and sub-parallel to the lower contact with an average strike approximately 60 degrees (°) and dips of 20°–52° to the southeast. The vertical thickness of the potentially mineable grades varies in width from 49 to over 591 ft (15 to 180 m), averaging from 197 to 328 ft (60 to

100 m). The depth of the potentially mineable grades ranges between 984 to -3,005 ft (300 to -916 m) amsl.

The Maturi deposit has not been significantly deformed, but it has been subjected to minor displacements along reactivated basement faults, as well as cross faults. Mapped structures are mostly sub-vertical north–northeasterly striking faults.

5.1.2 Soils and Topography / Landforms

The Project area is within the Nashwauk Uplands (212Lc) and Border Lakes (212La) subsections of the Northern Superior Uplands Section within the Laurentian Mixed Forest (LMF) Province (MDNR, 2019a). Wetlands commonly occur in the numerous depressions and potholes. The upland vegetation typically consists of fire-dependent forests and woodlands. Generally, the terrain within the Project area is flat to gently sloping with localized areas of small, steep ascents. From the low topographic point on the shoreline of Birch Lake, the topography gradually increases moving inland and culminates just east of the Project area. Within a mile of the Project area, topographic relief varies as much as approximately 200 ft (61 m).

5.1.2.1 Natural Resources Conservation Service Soil Data Survey

The Natural Resources Conservation Service (NRCS) maintains a public inventory of soil survey data for Minnesota. This inventory contains a variety of information on soil map unit distribution, physical and chemical characteristics, and information on soil usability for purposes such as structural foundations, septic fields, and other uses.

The NRCS soil survey data are complete for the entire Project area and there are no gaps in the mapping or the attribute data. NRCS soil survey data identified within the Project area are displayed on Figure 5-8 and Figure 5-9. Map unit descriptions, physical soil properties, hydric soil, soil engineering properties, including information on corrosion susceptibility and frost heave potential are described in Table 5-1. The most abundant NRCS soil map units within the Project area include Eveleth-Conic-Aquepts (I2b21D), Greenwood soils (J1a40A), Rollins-Cloquet (F25D), and Babbitt-Aquepts, (I2b19A).

Sensitive soils for this area include both hydric soils (which are susceptible to rutting in non-frozen conditions) and thin soils over shallow bedrock (which are susceptible to erosion when disturbed). Sensitive hydric soil units have at least 50% abundance of hydric components and include the following map units: Rifle soils (1021A), Greenwood soils (1022A), Aquepts-Tacoosh-Rifle (I3-11A), Cathro muck (J2-40A), and Bowstring / Fluvaquents soils (K2-10A). According to the NRCS data, predominantly hydric soils account for approximately 27% of the NRCS data within the Project area.

Sensitive shallow soils have bedrock within 60 inches (1.5 m) of the ground surface and include the following map units: Eaglesnest-Wahlsten (F2B), Eveleth-Conic (F4E), Eveleth-Eaglesnest-Conic (F3D), and Eveleth-Conic-Aquepts (F35D). According to the NRCS data, soils with depths to bedrock of <60 inches (1.52 m) account for <10% of the NRCS data within the Project area.

Table 5-1 Natural Resources Conservation Service Map Unit Descriptions

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
1003B	Udorthents, loamy (cut and fill land)	6	No	fills on moraines, beveled cuts on moraines	Well drained	Low	Not defined	Not defined
1020A	Bowstring and Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	26	Yes	flats on flood plains	Very poorly drained	High	Low	High
1021A	Rifle soils, 0 to 1 percent slopes	82	Yes	swamps on end moraines, swamps on outwash plains, swamps on till plains	Very poorly drained	High	High	High
1022A	Greenwood soils, 0 to 1 percent slopes	21	Yes	bogs on end moraines, bogs on outwash plains, bogs on till plains	Very poorly drained	High	High	High
F10D	Cloquet-Pequaywan complex, 0 to 18 percent slopes, pitted	24	No	pitted outwash plains	Well drained	Low	High	High
F10E	Cloquet-Pequaywan complex, 0 to 45 percent slopes, pitted	59	No	pitted outwash plains	Well drained	Low	High	High
F166A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	3	Yes	drainageways on moraines	Very poorly drained	High	Moderate	High
F19A	Pequaywan loam, 0 to 3 percent slopes	12	No	rises on outwash plains, flats on outwash plains	Moderately well drained	Moderate	High	Moderate
F21D	Quetico, stony-Rock outcrop complex, 15 to 35 percent slopes	11	No	moraines	Well drained	Low	High	Moderate
F22F	Eveleth-Conic complex, 20 to 50 percent slopes, very bouldery	2	No	moraines	Well drained	Moderate	High	Moderate
F23B	Rollins-Biwabik complex, 1 to 8 percent slopes, very rocky	20	No	moraines	Somewhat excessively drained	Low	High	Moderate
F25D	Rollins-Cloquet complex, 8 to 18 percent slopes	484	No	pitted outwash plains	Somewhat excessively drained	Low	High	Moderate
F29E	Shagawa, extremely stony-Beargrease, extremely stony-Tacoosh complex, 0 to 35 percent slopes	164	No	end moraines	Well drained	Low	High	Moderate
F2B	Eaglesnest-Wahlsten complex, 2 to 8 percent slopes, bouldery	342	No	moraines	Moderately well drained	Moderate	High	Moderate
F35D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly, complex, 0 to 18 percent slopes	73	No	moraines	Well drained	Moderate	High	Moderate
F3D	Eveleth-Eaglesnest-Conic complex, bouldery, 6 to 18 percent slopes, very rocky	23	No	moraines on till plains	Well drained	Moderate	High	Moderate
F40D	Rollins cobbly sandy loam, 8 to 18 percent slopes	10	No	kames, outwash plains	Somewhat excessively drained	Low	High	Moderate
F4E	Eveleth-Conic, bouldery-Rock outcrop complex, 18 to 30 percent slopes	25	No	moraines	Well drained	Moderate	High	Moderate
F5B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes, rocky	8	No	till plains on moraines	Somewhat poorly drained	High	High	High
F8D	Biwabik-Graycalm-Friendship complex, 0 to 18 percent slopes, pitted	22	No	pitted outwash plains	Excessively drained	Low	High	Moderate
F9B	Cloquet loam, 2 to 8 percent slopes	33	No	outwash plains	Well drained	Low	High	High
I2a10C	Quetico, bouldery-Insula, bouldery-Rock outcrop complex, 3 to 18 percent slopes	305	No	moraines on till plains	Moderately well drained	Moderate	High	High
I2a10D	Quetico, stony-Rock outcrop complex, 15 to 35 percent slopes	67	No	moraines	Well drained	Low	High	Moderate
I2a23G	Conic, very bouldery-Insula, very bouldery-Rock outcrop complex, 20 to 70 percent slopes	83	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
I2a31D	Eveleth-Eagelsnest-Conic complex, bouldery, 6 to 18 percent slopes, very rocky	158	No	moraines on till plains	Well drained	Moderate	High	Moderate
I2b19A	Babbitt, bouldery-Aquepts, rubbly complex, 0 to 3 percent slopes	401	No	rises on moraines	Somewhat poorly drained	Moderate	High	High
I2b20B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes, rocky	137	No	till plains on moraines	Somewhat poorly drained	High	High	High
I2b21D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly complex, 0 to 18 percent slopes, very rocky	2106	No	moraines	Well drained	Moderate	High	Moderate
I3-11A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	203	Yes	drainageways on moraines	Very poorly drained	High	Moderate	High
J1a40A	Greenwood soils, dense substratum, 0 to 1 percent slopes	1151	Yes	bogs on moraines	Very poorly drained	High	High	High
J2-40A	Cathro muck, depressional, dense substratum, 0 to 1 percent slopes	39	Yes	depressions on moraines	Very poorly drained	High	High	High
K1-10	Pits, gravel-Udipsamments complex	7	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
K2-10A	Bowstring and Fluvaquents soils, 0 to 2 percent slopes, frequently flooded	166	Yes	flats on flood plains	Very poorly drained	High	Moderate	High

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.

5.1.2.2 Ecological Land Types Data

The USFS maintains a public inventory of Ecological Land Types (ELT), which includes natural community information on geologic landforms, soils, and associated botanical assemblages within the SNF. These data are part of a hierarchy of landscape information that is intended to guide decision-making, inform environmental analyses, and direct the management and monitoring of natural resources on public lands. As defined in the Land and Resource Management Plan for the SNF (USFS, 2004), an ELT is:

"an ecological map unit which is a subdivision of landtype associations or groupings of landtype phases that are areas of land with a distinct combination of natural, physical, chemical and biological properties that cause it to respond in a predictable and relatively uniform manner to the application of given management practices. In a relatively undisturbed state and / or a given stage of plant succession, an ELT is usually occupied by a predictable and relatively uniform plant community."

The USFS ELT data are complete for the portion of the Project within Lake County. ELTs identified by the USFS within the Project area include those displayed on Figure 5-10 and Figure 5-11. ELT 1 and 5 are considered to have sensitive soils because of susceptibility to rutting and compaction. ELT 18 is considered to have sensitive soils because of susceptibility to erosion. Attributes of each ELT are described in Table 5-2.

Table 5-2 Ecological Land Type Map Unit Descriptions

Ecological Landtype Unit	Landtype Phase	Acres Within the Project Area[1]
1	Poorly drained, loamy soils, greater than 40 inches deep, surface coarse fragment content ranges from 25 to 90 percent in drainways and depressions.	291
4	Poorly and very poorly drained fibrist greater than 60 inches deep, occurring in depressions and former lake beds.	458
5	Well drained, 2.5 yellow-red to 10 yellow-red, sandy loam or loam 8 inches deep over bedrock, occurring on ridge top and upper slope positions. Bedrock out-cropping can range from 5-50 percent.	390
7	Somewhat poorly drained, 10 yellow-red or 2.5 yellow-red, sandy loam, loam and/or silt loam greater than 40 inches deep, occurring in drainways, lower concave slopes, and in a transitional position between well drained and poorly drained sites. Coarse fragment content can range to 35 percent.	111
10	Moderately well or well drained, 10 yellow-red to 2.5 yellow sandy loam and/or loam greater than 40 inches deep, occurring on ridge positions. Clay content is less than 18 percent. B horizons are 10 yellow-red.	68
14	Well drained 7.5 yellow-red or 10 yellow-red sandy loam and loamy sand, greater than 50 percent fine sand, less than 20 inches deep over 10 yellow-red, gravelly coarse sand greater than 40 inches deep, with greater than 35 percent coarse fragments. Landscape position is upper elevation in outwash plain. Sand size includes fine through very coarse.	296
18	Well drained, 5 yellow-red to 10 yellow-red, sandy loam and/or loam, 20 to 40 inches deep over bedrock, occurs on bedrock controlled ridges.	1642

Ecological Landtype Unit	Landtype Phase	Acres Within the Project Area[1]
21	Well drained, 10 yellow-red to 2.5 yellow-red, sandy loam or loam 8 to 20 inches deep over bedrock, 7.5 yellow-red B horizons are common. Controlled ridge tops and upper slopes	1076
24	Poorly drained, hemist greater than 53 inches deep, occurring in depressions and former lake beds.	816
28	Well drained 10 yellow-red loamy sand or loamy fine sand less than 12 inches deep with over 2.5 yellow-red to 2.5 yellow sand greater than 40 inches deep occurring upper elevation positions on outwash or lacustrine plains. Sand in size includes fine through very coarse. Gravel content is less than 35 percent.	30
30	Well drained, 7.5 yellow-red or 5 yellow-red, fine sandy loam, 16 to 24 inches deep over 10 yellow-red, very gravelly sandy loam or very gravelly loamy sand, greater than 40 inches deep and occurring on ridges. A discontinuous fragipan can occur at 16-24 inches. Coarse fragment content of the C horizon ranges from 35 to 50 percent.	267
32	Poorly drained, organic material 18 to 53 inches deep over mineral soils occurring in drainways and depressions.	51
46	Moderately well drained 5 yellow-red to 10 yellow-red sandy loam or loamy sand less than 20 inches deep over gravelly sand. Water table and/or mottling within 60 inches. Coarse fragment content is variable. Landscape position lower elevation concave areas in an outwash glacial drainages and terraces.	1
47	Poorly drained, 10 yellow-red or 2.5 yellow-red, sandy loam, loam, clay loam, and/or silt loam greater than 40 inches deep, occurs in drainways and depressions. Histic epipedons can occur. Surface coarse fragment content is less than 25 percent.	194
89	Water (lake or river), intermittent water body	39
99	Gravel pit, landfill, or quarry	7

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.

Abbreviations:
BR Bedrock
GP Gravel Pit
INT Intermittent Water Body
LF Landfill
NM Not Mapped
Q Quarry
W Water
No symbol Less than 6 percent
A 0 to 6 percent
B 7 to 18 percent
C 19 to 35 percent
D 36 to 50 percent
E 51 plus percent

5.1.2.3 Unconsolidated Material Thickness

In addition to the NRCS and ELT data, the thickness of unconsolidated sediments was recorded during the installation of monitor wells in and around the underground mine area and is shown on Figure 5-12. Monitor well records indicate most unconsolidated deposits range from 0 to 20 ft (0 to 6 m) thick near the underground mine area.

5.1.3 Rock and Mineral Geochemical Characterization

Geochemical characterization is a method for evaluating the reactivity of rock, minerals, and the potential for generation of ARD and ML. ARD is a result of the natural oxidation of sulfide minerals when exposed to air and water. Associated geochemical processes can also lead to ML, which is the release of metals into solution.

The ARD and ML potential of Duluth Complex rocks, rocks which host the targeted mineralization, has been studied extensively by the MDNR, USGS, and private industry through both laboratory and field scale testing methodologies (e.g., Kellogg, et., al., 2014; Lapakko et., al., 2013; PolyMet, 2015; Schulte, et., al., 2016; and Wenz, 2016). In particular, MDNR has been conducting ongoing studies since the late 1970s. Many of the studies conducted have incorporated a tool known as kinetic testing, which demonstrates how a rock type weathers over time and allows for the identification of weathering rates. Kinetic testing are primarily intended to generate information on weathering rates of primary minerals (e.g., sulfides); information that can be used to estimate the potential for future net-acid conditions. Dissolution rates of readily soluble primary and secondary minerals present at the onset of testing can also be derived from kinetic testing results. Analysis of these weathering rates allows for the identification of whether ARD and ML is produced over time and to what extent. In some cases, kinetic testing has been conducted for more than a decade on Duluth Complex rocks and has led to a fundamental understanding of the potential for ARD and ML.

Although a fundamental understanding of the potential for ARD and ML within Duluth Complex rocks exists, TMM is developing a Project-specific material characterization program in consultation with MDNR and in alignment with Minn. R., part 6132.1000. This program is ongoing and can be divided into three components:

- Preliminary characterization of sulfide mineralization and ARD and ML potential of tailings, waste rock, and ore associated with the Duluth Complex and GRB rock;
- Future utilization of characterization data to further inform material management; and
- Develop a plan for inclusion of data obtained from the material characterization program into modeling to further understand potential impacts to water quality.

To date, TMM has conducted chemical analysis (elemental and whole rock analysis), acid-base accounting, net acid generation, and mineralogical and petrological analyses, and preliminary kinetic testing on waste rock and ore; and chemical composition, acid base accounting, mineralogical and petrological analyses, and preliminary kinetic testing on tailings. Future material characterization of the waste rock ore, and tailings will need to include continued static testing to inform necessary kinetic testing and additional mineralogical analysis.

Tailings samples included in the chemical composition, acid base accounting, and preliminary kinetic testing analyses were obtained from pilot plant testing conducted in March 2013. The material source for pilot testing originated from drill core in the western portion of the Maturi deposit. Total sulfur concentrations within the tailings were found to be less than or equal to 0.2 weight percent (wt. %). These low sulfur concentrations in the tailings occur because most of the sulfur is removed in the flotation process and would be captured as part of the concentrate material (the marketable product). The dominant mineral types found in the tailings are plagioclase, olivine, and pyroxene, which have been shown to provide neutralization potential. Leachate from initial kinetic testing of the tailings material was non-acidic over a 20-week period.

A future work scope for the continued development and execution of the material characterization program can be found in Section 5.3.

5.2 Project Impacts

5.2.1 Subsidence and Crown Pillar Stability

A crown pillar is defined as the “rock bridge left between the upper most underground openings and the top of the bedrock.” Subsidence is the surface movement associated with the creation of any excavation of the ground from trenching, open pit mining, or underground mining. Subsidence is created when the surrounding ground moves through either an elastic response or through failure that fills the excavated void. The amount and extent of subsidence associated with mining depends on the type of mining, the size of the openings, the depth of the workings, the geology of the deposit, and the strength of the rock.

A preliminary analysis of subsidence and crown pillar stability was completed. To assess the potential impacts from subsidence, a three-dimensional numerical simulation was developed based on the 25-year operation of the Project. Using expected average rock mass quality and assuming no backfill would be present, the simulation indicated that surface deformations may manifest as a positive heave above the crown pillar of +1/16 to +1/8 inch (or +2 to 3 mm) with subsidence in the range of -1/24 to -1/16 inch (-1 to -2 mm) over areas where mining occurs at greater depths below ground surface (bgs).

Simulations conducted for the 25-year operation of the Project using the worst-case rock mass quality indicated heave above the crown pillar and subsidence above areas where mining occurs at greater depths would be in the range of ±2/3 inch (or ±16 mm). The extent of these modeled surface deformations would be substantially less than frost heave action of 1.5 inches (38 mm) for a typical 10 ft (3 m) depth of unconsolidated deposit assuming a 35% saturated porosity and frost action down 4 ft (1.2 m).

The same analysis modeled the impacts of crown pillar stability for the Project. Typically, surficial impacts associated with crown pillar stability manifest similarly to subsidence and can result in the lowering of ground surface.

Stability of the crown pillar was analyzed using the internationally recognized empirical Scaled Span Crown Pillar assessment, as well as numerical modeling. The analysis assessed several configurations of the crown pillar and strength of the rock mass to determine that the crown pillar "would be stable with a Reliability of around 99%" indicating there would be minimal, if any, anticipated impact resulting from crown pillar stability. The results indicated "long-term use is suitable for public access, with limited to no concern regarding conditions on closure."

The analysis indicated that no perceptible subsidence is expected. The extent of potential subsidence and crown pillar stability impacts, assuming no backfilling, would be within the range of surface deformations associated with naturally occurring environmental conditions such as frost heave. Modeling the stability of the mine without backfill would over-estimate the potential for subsidence as backfill provides pillar confinement increasing the geotechnical stability of the mine (further reducing the potential for subsidence).

5.2.2 Volume and Acreage of Soil Excavation and Grading

Impacts from soil excavation and grading would be associated with the construction phase of the Project, primarily. The principal NRCS soil classifications that have the potential to be impacted include Eveleth-Conic-Aquepts (I2b21D), Greenwood soils (J1a40A), Rollins-Cloquet (F25D), and Babbitt-Aquepts, (I2b19A). The principal ELT classifications that have the potential to be impacted include: Upland Shallow Loamy Dry (16), Upland Very Shallow Loamy Droughty (17), and Upland Extremely Shallow Loamy Droughty (18). During construction, it is estimated that the Project would excavate approximately 2.2 million yd^3 (1.7 million m^3) and grade approximately 984.2 acres (398.3 ha).

5.2.3 Soils and Topography Environmental Protection Measures

The potential for impacts to soils and topography are associated with clearing and grubbing practices during the construction phase of the Project, as well as development of the dry stack facility during the operations phases.

EPMs employed to reduce soil erosion during construction may include temporary control measures such as silt fences, sediment logs, and other industry standard construction stormwater controls. In addition to control measures employed during the construction phase of the Project, BMPs would be used to limit the erosional effects of wind and stormwater during operation and closure. BMPs that would be used may include:

- Surface stabilization measures – Compaction, surface roughening, dust control, mulching, erosion matting, riprap, temporary gravel construction access, temporary and permanent revegetation / reclamation, and placing plant growth media;
- Run-off and run-on control and conveyance measures – engineered channels, grade stabilization structures, ditch checks, run-off and run-on diversion berms; and

- Sediment traps and barriers – sediment detention basins, sediment traps, drill sumps, stabilized construction entrances, tire wash stations, silt fence, wattles, and straw bale barriers.

Sediment and erosion control BMPs would be routinely inspected, evaluated for performance, and maintenance and repairs performed, as needed. Disturbed areas would be revegetated to reduce the potential for wind and water erosion. Revegetation concurrent with construction activities would be maximized to the extent practicable to accelerate revegetation of disturbed areas. Construction stormwater control measures and management systems are discussed in further detail in Section 6.2.2.

Soils removed during construction would be stored in stockpiles and used for reclamation purposes. Reclamation as described in Section 3.6.2, would be designed to meet Minn. R., chapter 6132, to “ensure that the mining area is left in a condition that protects natural resources.”

The potential erodibility of tailings used to construct the dry stack facility would be minimized through Project design measures such as slope, compaction, soil cover, and vegetation. These measures have been incorporated into the design of the dry stack facility and would be implemented in conjunction with EPMs.

5.2.4 Geology, Soils, and Topography / Landform Impacts Summary

The available information is adequate to make a reasoned decision about the potential for, and significance of, the Project impacts to geologic, soil, and topographic resources. The potential impacts associated with soils and topography or subsidence and crown pillar stability are characterized in the following manner:

- Temporary – The potential geologic impact to soils associated with erosion would be anticipated to be temporary. EPMs have been included in Project design to reduce impacts from stormwater during the construction, operation, and closure phases of the Project. The analysis of subsidence and crown pillar stability indicates no perceivable impact would be anticipated;
- Extent – Potential geologic impacts to soils would result in areas where soil disturbing activities occur. The extent of impact would be anticipated to be 2.2 million yd^3 (1.7 million m^3) of excavation and 984.2 acres (398.3 ha) of grading. The extent of potential impacts would be reduced through Project design measures such as stormwater controls and reclamation practices; and
- Regulatory Oversight – Potential impacts associated with soil stabilization, erosion control, and stormwater management would be subject to continual oversight by the Minnesota Pollution Control Agency (MPCA). Potential impacts and required soil stabilization associated with reclamation would be subject to continual oversight from MDNR.

The analysis of potential geologic impacts associated with subsidence and crown pillar stability, and soils and topography did not identify any potential significant effects, and the topic is considered minor.

5.3 Future Scope

5.3.1 Materials Characterization

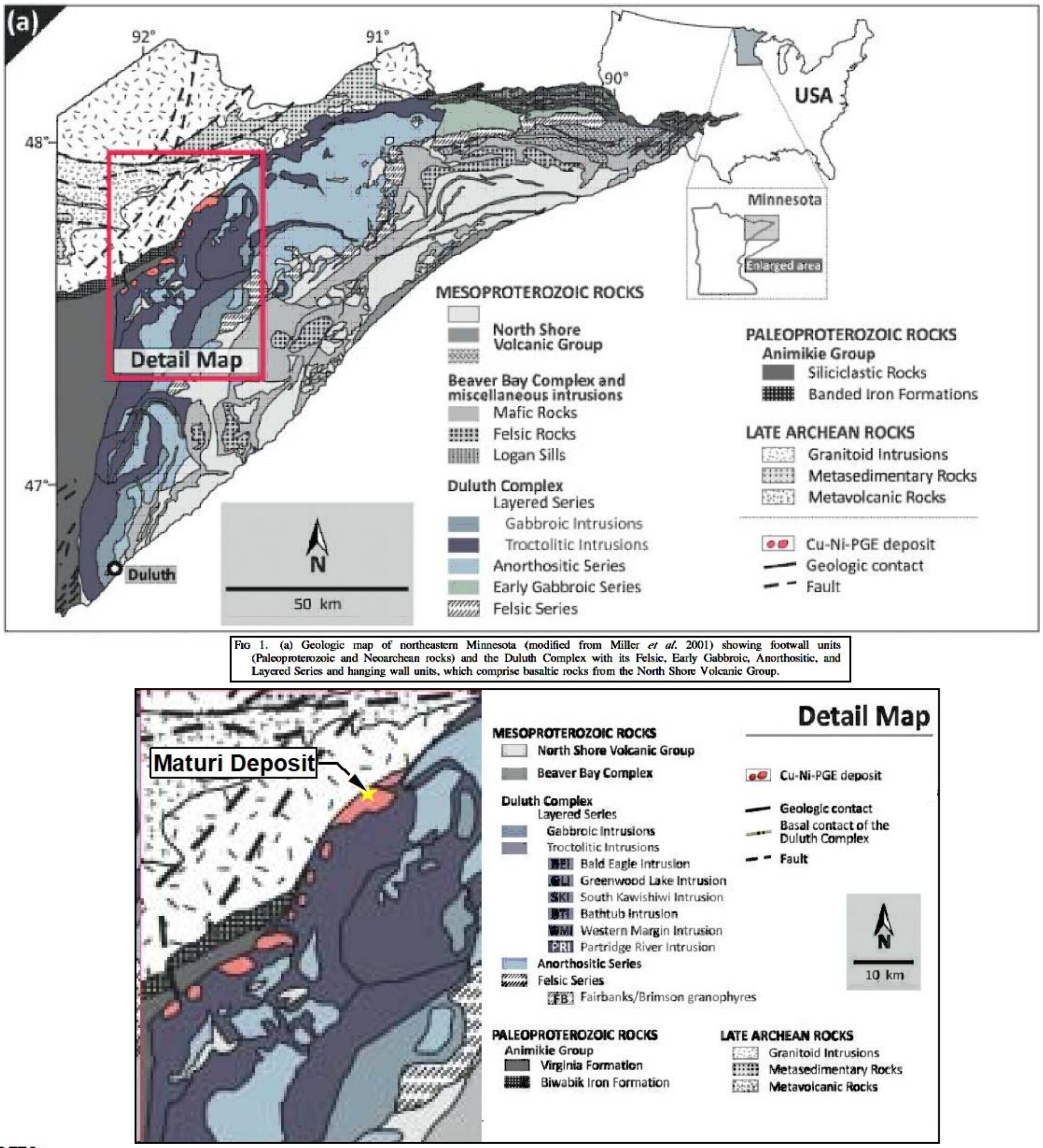
The development and implementation of the materials characterization program is an ongoing effort by TMM which will culminate in documentation which captures the following information:

- A framework for the materials characterization program including common terminology, incorporated references, and commonly used acronyms;
- An overall Project description as it relates to geology, resource development, and anticipated facilities;
- A work plan for the characterization of waste rock, submerged waste rock, ore, and tailings including data quality objectives, testing methods, sample selection rationale, laboratory selection, and data management;
- A work plan for the implementation of the program to include sample group selection and testing proposals;
- A work plan for the implementation of the program, and
- A summary of results for both static testing and kinetic testing.

The current focus of the material characterization program is kinetic testing. Results from future static and kinetic testing will further inform material management and engineering controls, as necessary. In addition to informing material management and engineering controls, data from the material characterization program will be used as an input to water quality modeling outlined in Section 6.3.1.

5.3.2 Subsidence and Crown Pillar Stability

Additional analysis of the potential for subsidence and review of crown pillar stability will be provided as part of a geotechnical data package during EIS development.



NOTES:

1. Figure content from Raic, et al. (2015). Arsenic-Rich Cu-Ni-PGE Mineralization in Wetlegs, Duluth Complex, St. Louis County, Minnesota, USA. The Canadian Mineralogist, Vol. 53, pp. 105-132 (2015) DOI: 10.3749/canmin. 1400053

TWIN METALS MINNESOTA

GEOLOGY OF THE DULUTH COMPLEX

Scale: AS SHOWN | Date: JULY 2020

Figure 5-1 Geology of the Duluth Complex

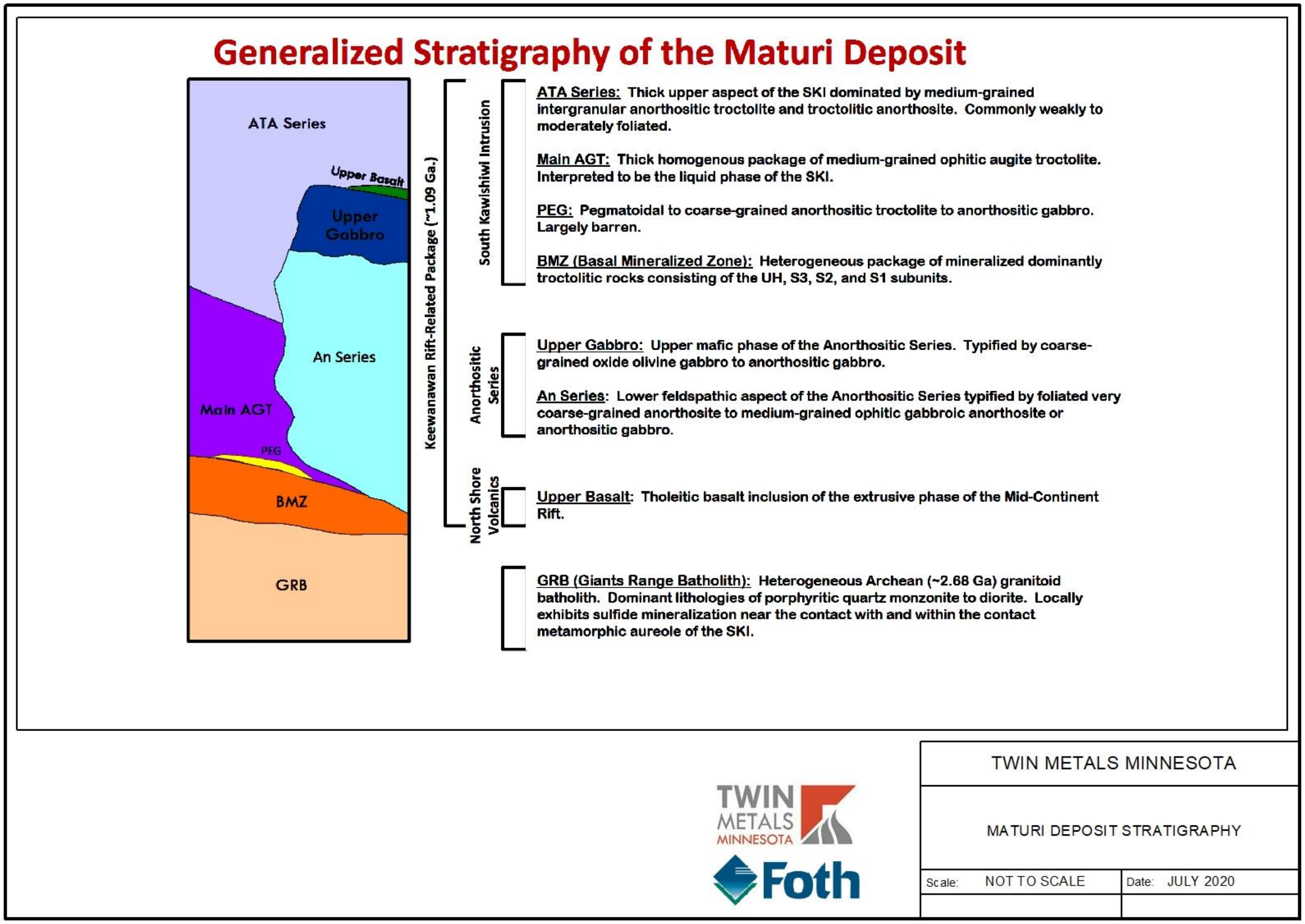


Figure 5-2 Maturi Deposit Stratigraphy

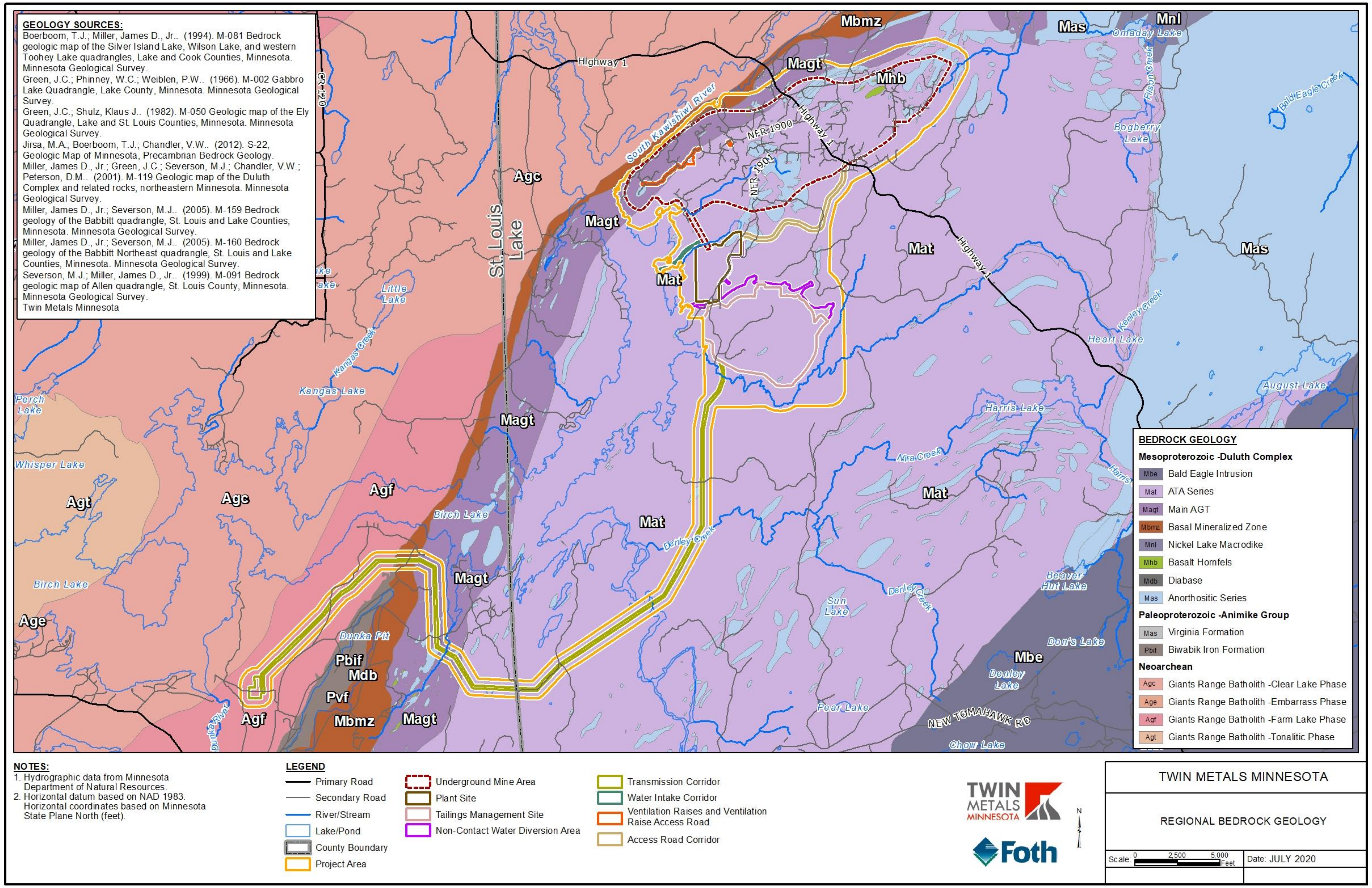


Figure 5-3 Regional Bedrock Geology

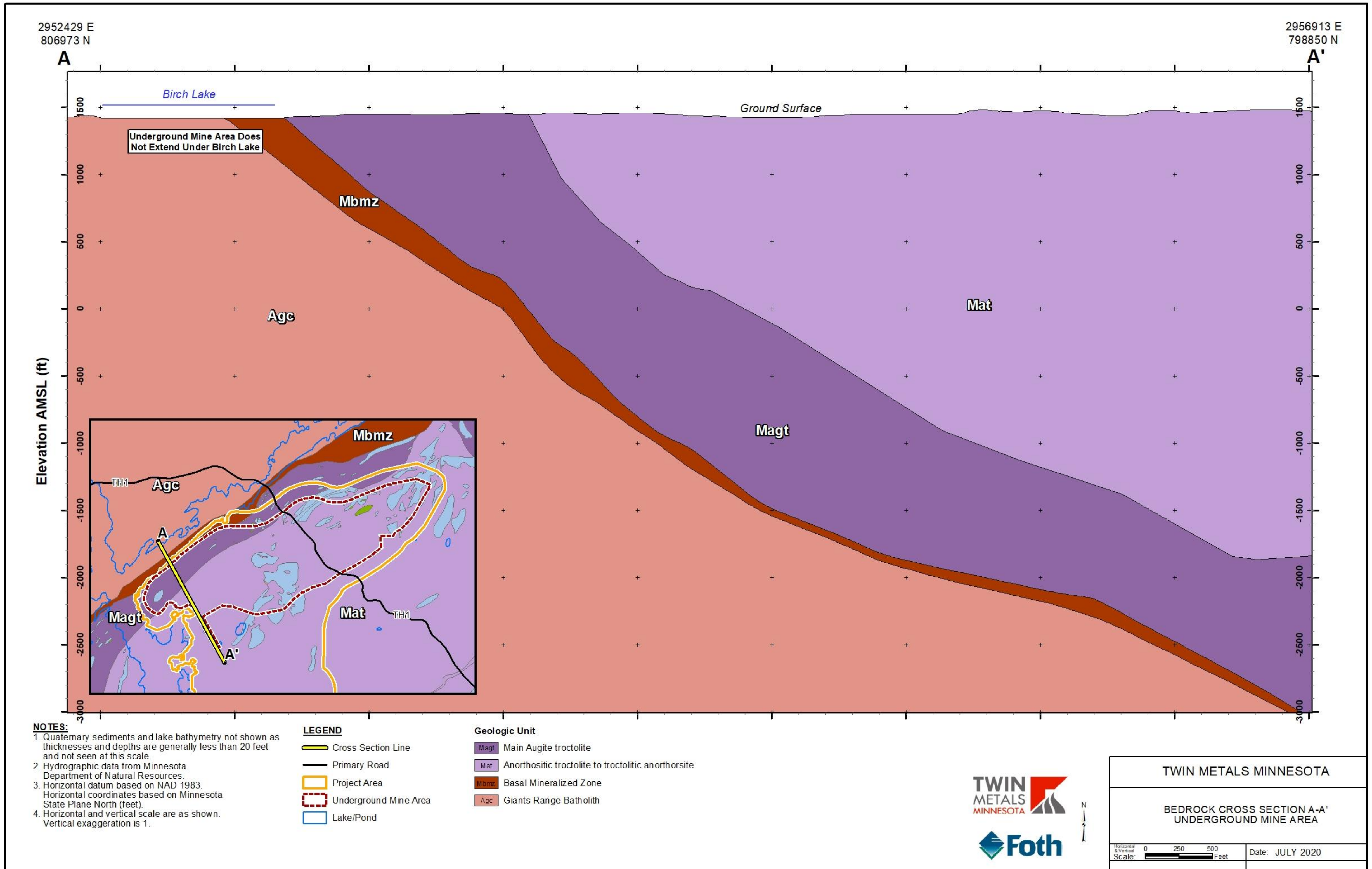


Figure 5-4 Bedrock Cross Section A-A' Underground Mine Area

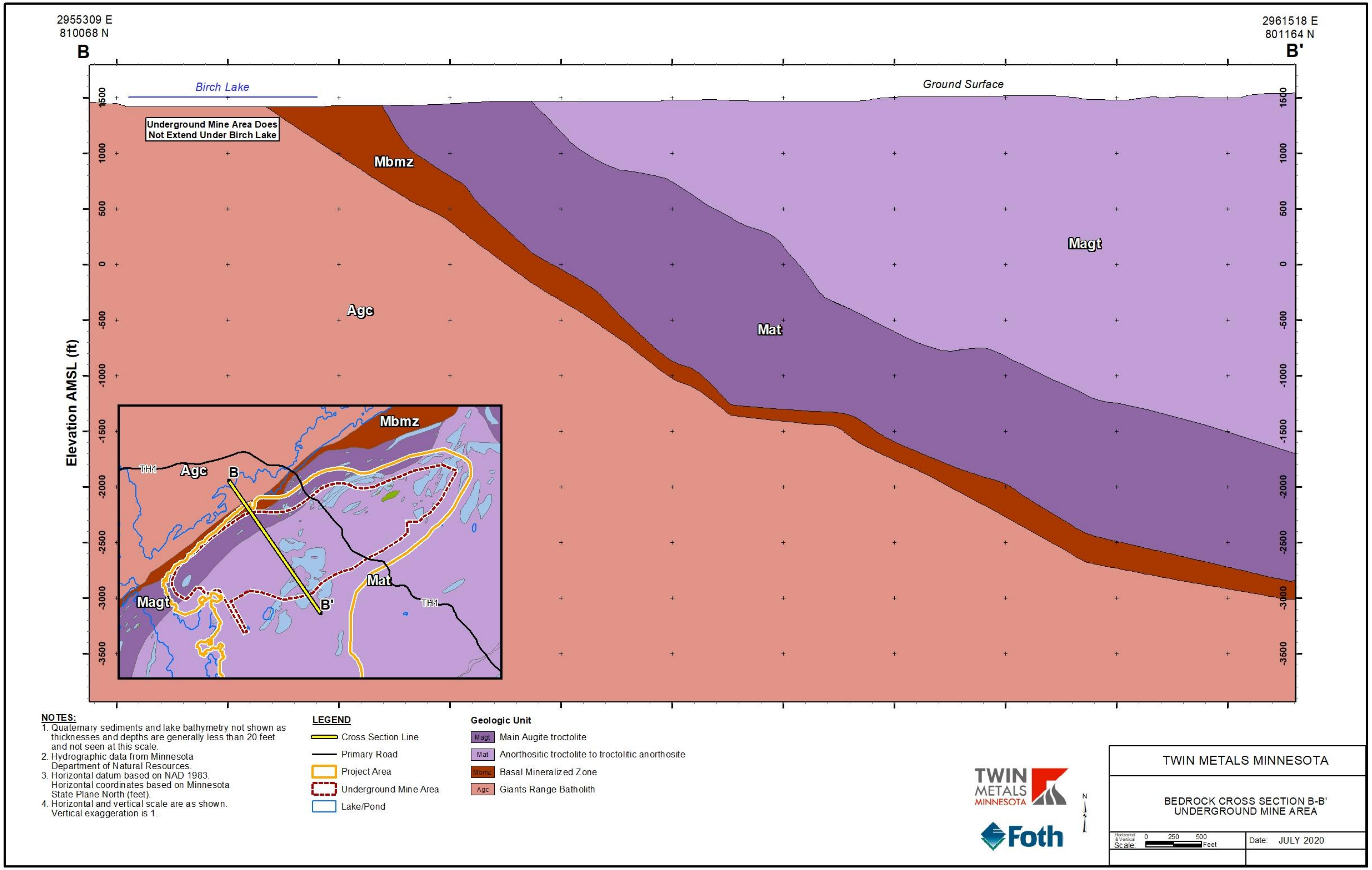


Figure 5-5 Bedrock Cross Section B-B' Underground Mine Area

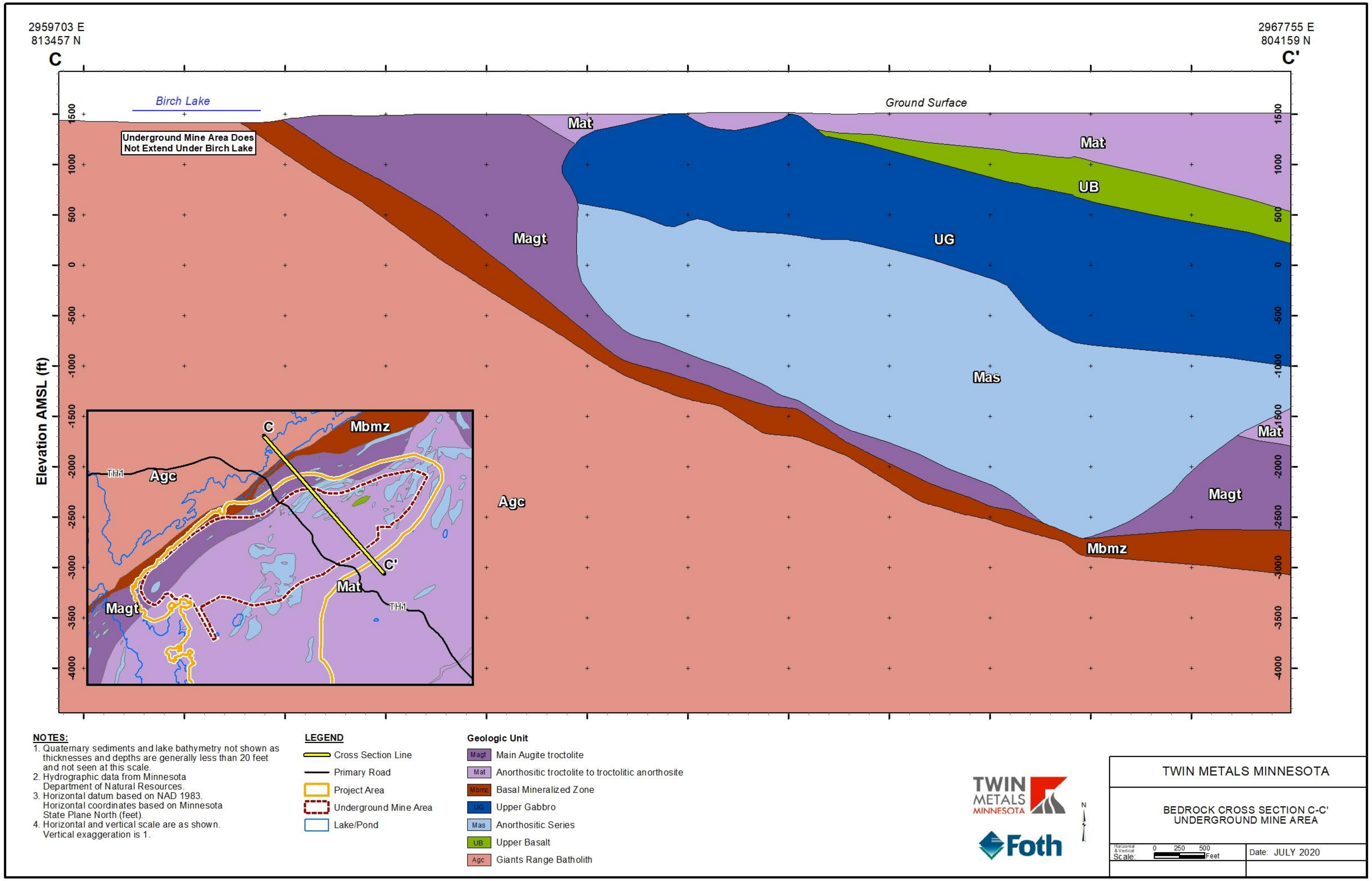


Figure 5-6 Bedrock Cross Section C-C' Underground Mine Area

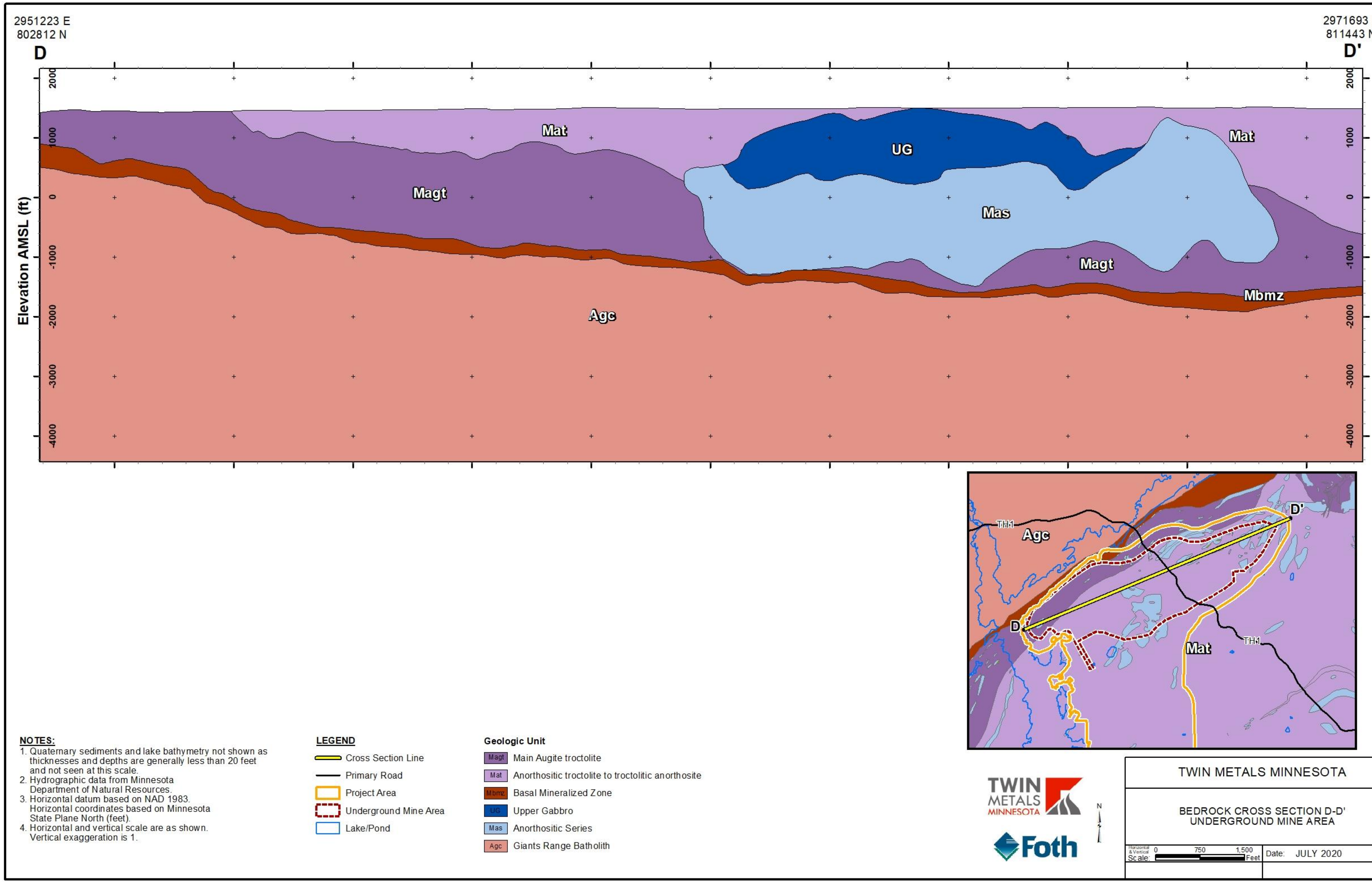


Figure 5-7 Bedrock Cross Section D-D' Underground Mine Area

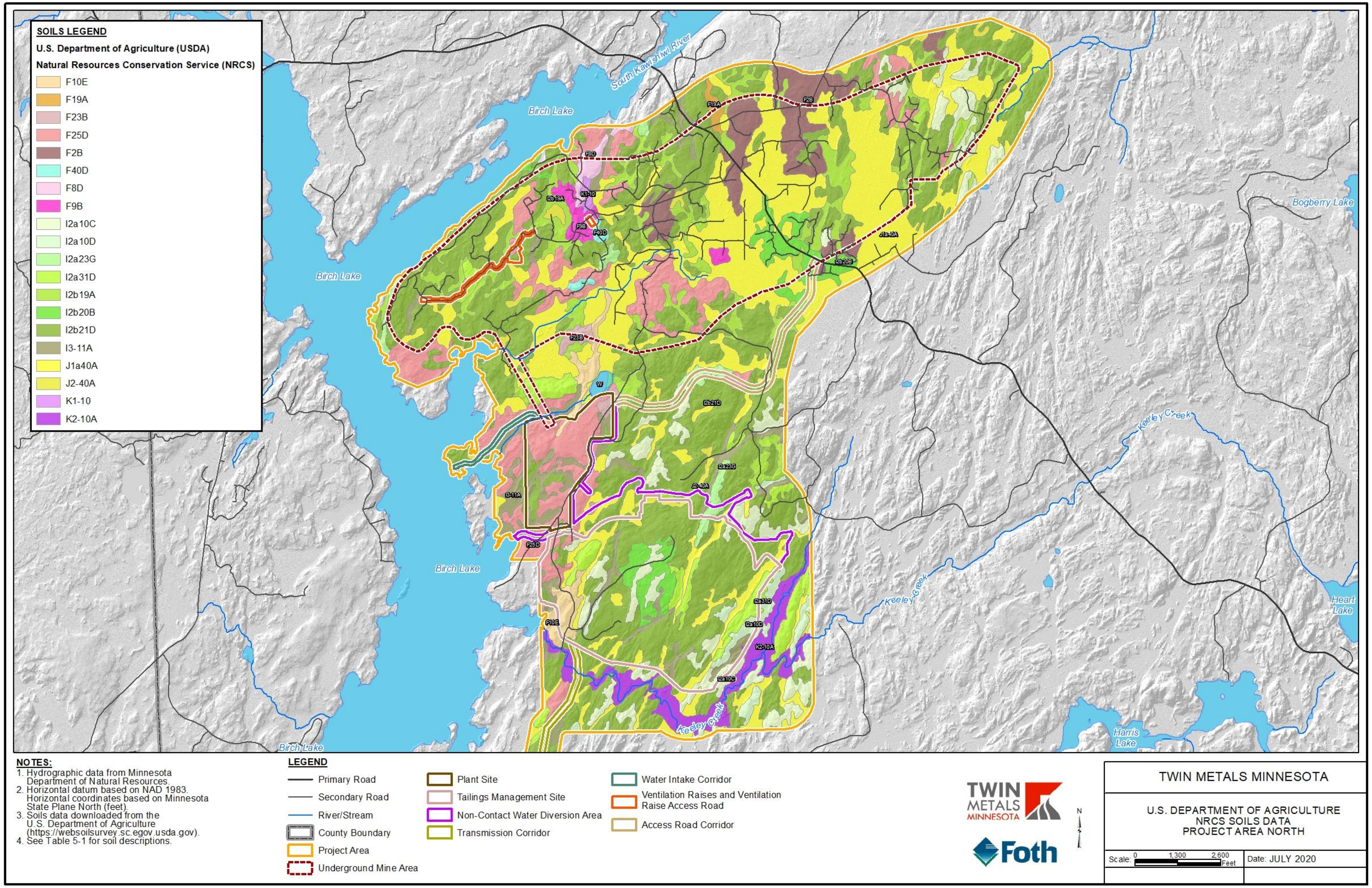


Figure 5-8 U.S. Department of Agriculture NRCS Soil Data Project Area North

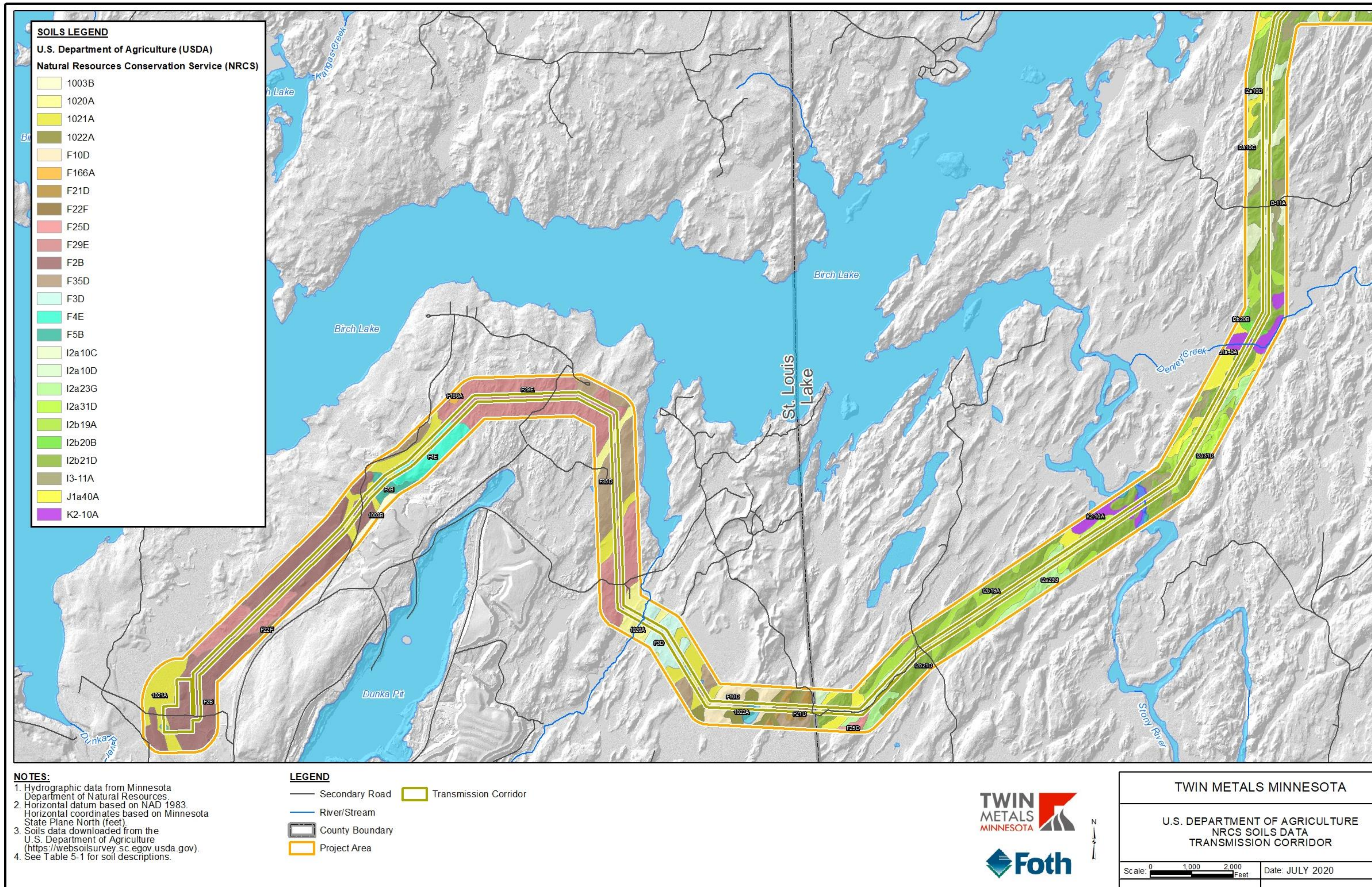


Figure 5-9 U.S. Department of Agriculture NRCS Soils Data Transmission Corridor

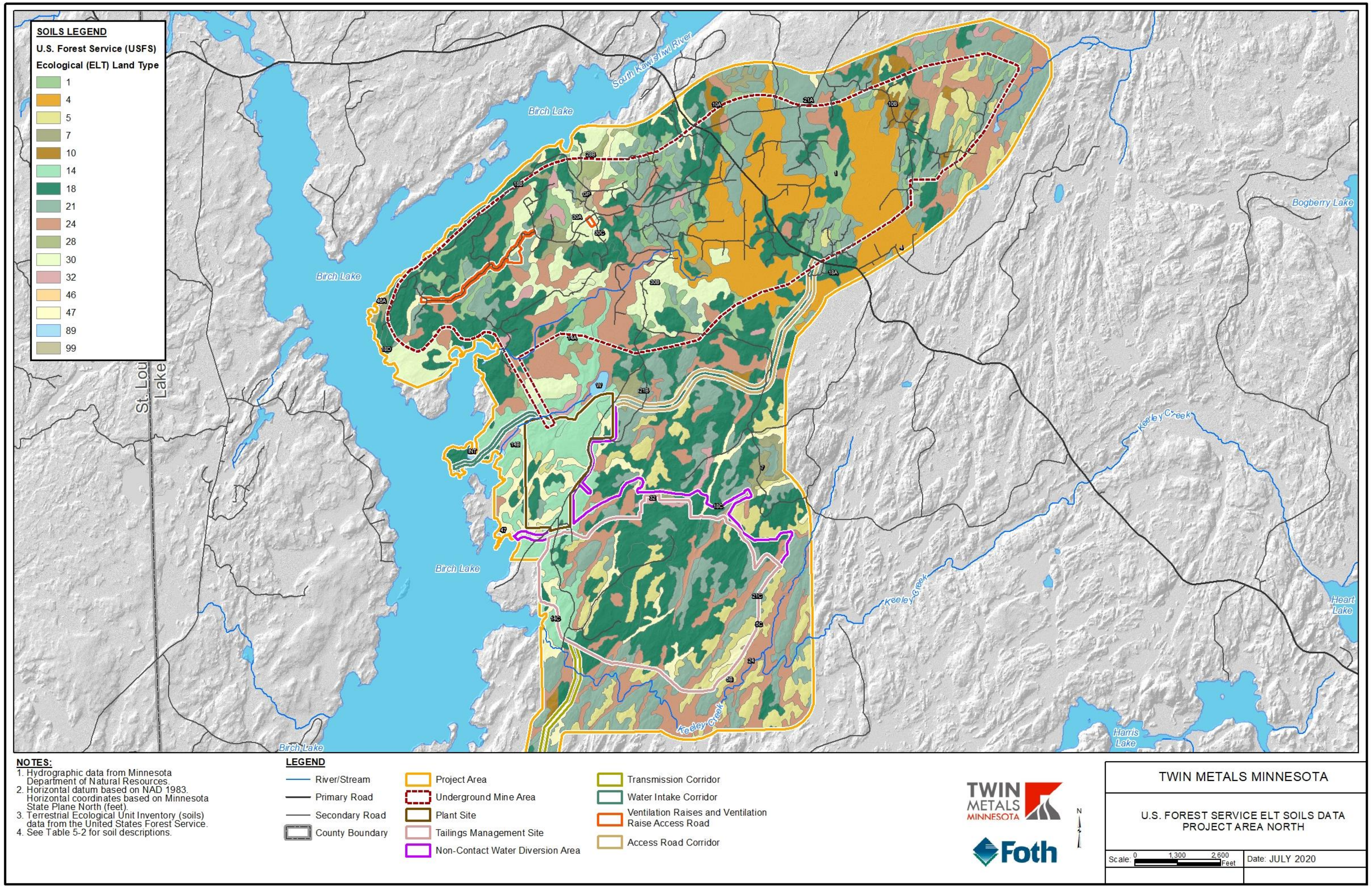


Figure 5-10 U.S. Forest Service ELT Soils Data Project Area North

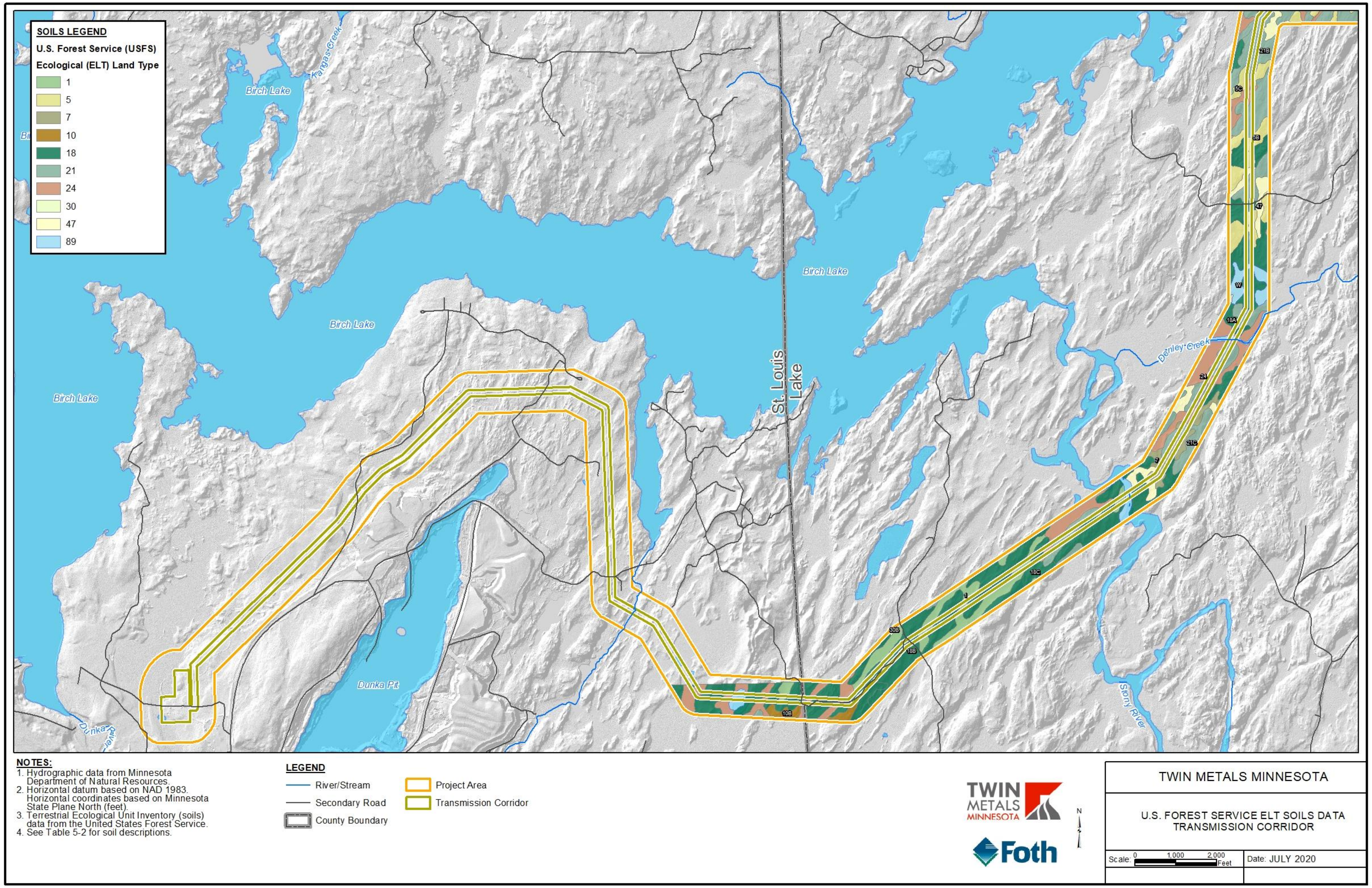


Figure 5-11 U.S. Forest Service ELT Soils Data Transmission Corridor

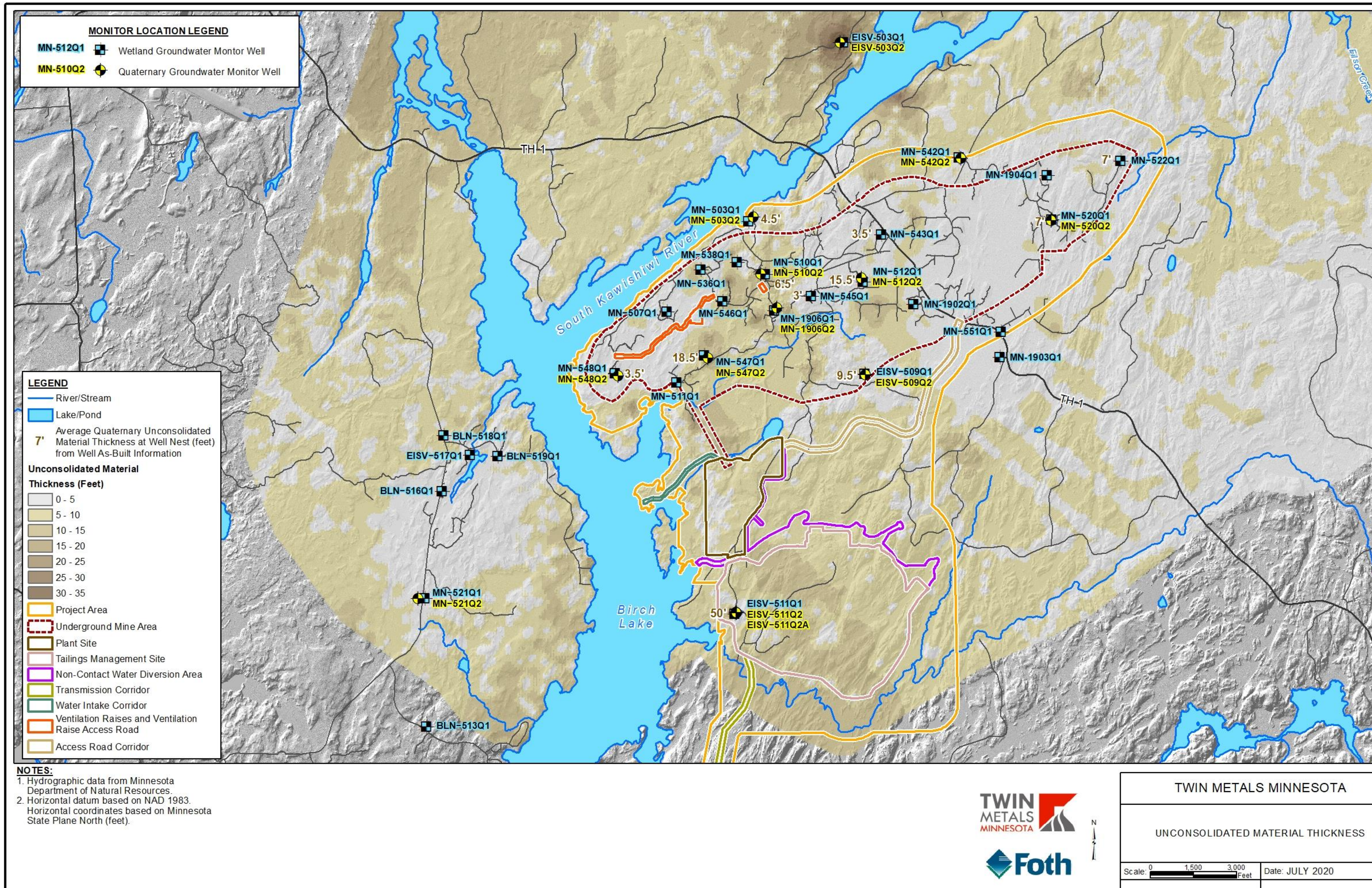


Figure 5-12 Unconsolidated Material Thickness

6.0 WATER RESOURCES

6.1 Baseline Conditions

This section describes baseline conditions for surface water, groundwater, and wetlands in the vicinity of the Project area. For each of these water resources, this section identifies the resources in the vicinity of the Project area, describes the available information, and summarizes the baseline characteristics of the resources.

6.1.1 Surface Water

This section identifies the watersheds and surface water bodies in the vicinity of the Project area, describes the available data sources, and summarizes baseline hydrology, stream morphology, and surface water quality.

6.1.1.1 Watersheds and Waterbodies in the Vicinity of the Project Area

The Project would be located north of the Laurentian Divide with water flowing north towards Hudson Bay. The USGS defines this at a broad scale as the Rainy Headwaters (HUC-8 Subbasin [HUC 09030001]). The same area is defined by MDNR as the Rainy River Headwaters Major Surface Water Watershed. USGS HUC boundaries are shown on Figure 6-1 and MDNR watershed boundaries are shown on Figure 6-2. Figure 6-3 shows PWI waterbodies in the vicinity of the Project area.

At a finer watershed scale, the Project area is within the USGS Birch Lake and Stony River watersheds (HUC10) and Birch Lake, South Kawishiwi River, Denley Creek, and Outlet Stony River sub-watersheds (HUC12). The Project area is within the MDNR South Kawishiwi River, Filson Creek, Keeley Creek, Denley Creek, Stony River, and Unknown minor watersheds shown on Figure 6-2. Table 6-1 and Table 6-2 show the area of Project features within the HUC and MDNR watersheds. PWI waterbodies within 1 mile of the Project area are listed on Table 6-3 and Table 6-4.

Table 6-1 Minnesota Department of Natural Resources Minor Watershed Project Component Watersheds

Watershed	Total Watershed Size	Project Area[1]	Underground Mine Area	Plant Site	Tailings Management Site	Transmission Corridor	Non-Contact Water Diversion Area	Water Intake Corridor	Ventilation Raises and Ventilation Access Road	Access Road
South Kawishiwi River	35778	3926.2	1735.5	152.9	121.4	111.0	62.3	7.5	14.9	43.6
Keeley Creek	7003	1274.7	0	0	532.0	9.5	34.3	0	0	0
Filson Creek	6515	327.7	125.9	0	0	0	0	0	0	0
unknown	12956	317.6	125.1	0	0	0	0	0	0	0
Stony River	18058	260.4	0	0	0	38.9	0	0	0	0
Denley Creek	11476	180.6	0	0	0	27.6	0	0	0	0

Notes:
Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.
All amounts shown in acres
[1] Acreages for the Project area shown on Figure 6-1.

Table 6-2 U.S. Geological Survey HUC12 Project Component Watersheds

Watershed	Total Watershed Size	Project Area[1]	Underground Mine Area	Plant Site	Tailings Management Site	Transmission Corridor	Non-Contact Water Diversion Area	Water Intake Corridor	Ventilation Raises and Ventilation Access Road	Access Road
Birch Lake	42806	5200.9	1735.5	152.9	653.4	120.5	96.6	7.5	14.9	43.6
South Kawishiwi River	19482	645.3	251.0	0	0	0	0	0	0	0
Outlet Stony River	29994	260.4	0	0	0	38.9	0	0	0	0
Denley Creek	11482	180.6	0	0	0	27.6	0	0	0	0

Notes:
Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.
All amounts shown in acres
[1] Acreages for the Project area shown on Figure 6-1.

Table 6-3 Public Water Basins within 1 Mile of the Project Area

County	Public Water Identification #	Public Waters Name	Section	Township	Range
Lake	38-774P	Unnamed	31	61	11
Lake	38-775P	Unnamed	31	61	11
St. Louis/Lake	69-3P	Birch Lake	Various	60; 61	11; 12; 13

Table 6-4 Public Watercourses within 1 Mile of the Project Area

County	Name
Lake	South Fork Kawishiwi River
Lake	Keeley Creek
Lake	Denley Creek
Lake	Stony River
St. Louis	Dunka River

In addition to the USGS and MDNR watersheds, five Project-specific watersheds were selected for evaluation in the vicinity of the Project area as shown on Figure 6-4, for future modeling and analysis of surface water flow. The Project-specific basins consist of sub-basins within the USGS / MDNR basins and were delineated by using a combination of light detection and ranging (LiDAR) imagery, outcrop mapping, and actual surveyed points from well completions to interpolate the drainage basin boundaries. The Project-specific watersheds include the MDNR designated Keeley Creek Minor Watershed (Watershed 1), Filson Creek Minor Watershed (Watershed 2), and portions of Birch Lake Minor Watershed split into three Project watersheds (Watersheds 3, 4, and 5), excluding Birch Lake and the South Kawishiwi River and terminating to the north at the dam on Birch Lake. Acreages for the five Project-specific watersheds are the following:

- Watershed 1 (Keeley Creek) – 7,005 acres (2,835 ha);
- Watershed 2 (Filson Creek) – 6,517 acres (2,637 ha);
- Watershed 3 (Birch Lake North) – 2,839 acres (1,149 ha);
- Watershed 4 (Birch Lake West) – 3,099 acres (1,254 ha); and
- Watershed 5 (Birch Lake Southeast) – 4,872 acres (1,971 ha).

Topography in the five Project-specific watersheds generally slopes towards Birch Lake and towards the South Kawishiwi River. The high point is on the divide between Watershed 1 and Watershed 5 at approximately 1,610 ft (490.7 m) amsl compared with the elevation on the lake shore of approximately 1,420 ft (432.8 m) amsl.

Birch Lake is the largest water body in the vicinity of the Project area. It was originally a complex of river beds before the 1890s when it was impounded for log transport (Reavie, 2013) by a dam at its northern end where it feeds into White Iron Lake through the South Kawishiwi River. Birch Lake has a maximum depth of 25 ft (7.6 m) and the water level can drop by as much as 4 ft (1.2 m) in winter according to water management needs of the Winton Hydroelectric Station located on the South Kawishiwi River between Garden Lake and Fall Lake.

Figure 6-5 presents a diagram of conceptualized surface water flow through the Birch Lake and Stoney USGS Major Watershed. The three main inlets to Birch Lake are the South Kawishiwi River to the northeast, the Birch River to the west, and the Dunka River to the south. Stony River and Denley Creek, both part of the Stony River watershed, are also tributaries to Birch Lake.

Surface water in all of the Project-specific watersheds drains towards Birch Lake and the South Kawishiwi River. North Nokomis Creek (Kittle Number: H-001-092-017.4) originates from the underground mine area and flows into Birch Lake, and South Nokomis Creek (Kittle Number: H-001-092-017.2) flows just north of the plant site before flowing into Birch Lake. North Nokomis Creek and South Nokomis Creek are designated by both their local name from past field work and their Kittle Number to provide clarity to the reader. An unnamed creek originates at the eastern end of the underground mine area and flows into Filson Creek. Two unnamed creeks originate from Watershed 4 and flow into Birch Lake. Crocket Lake, located in Watershed 3, flows into a creek that flows across Watershed 3 and into the South Kawishiwi River. The South Kawishiwi River flows southwest past the underground mine area into Birch Lake. Birch Lake is dammed where Trunk Highway (TH) 1 crosses over and flows into White Iron Lake below the dam.

Public waters basins and watercourses within one mile of the Project area are listed in Table 6-3 and Table 6-4.

6.1.1.2 Data Sources

Surface water investigation activities date back to 1951 with USGS gaging station data. Site-specific investigative activities including stage readings, flow measurements, and water quality testing, have been undertaken by TMM from 2007 to the present. TMM has monitored over 65 surface water sites including streams, lakes, reservoirs, and rivers.

All publicly available and site-specific surface water hydrology and water quality monitoring sites are identified on Figure 6-6 and summarized in Table 6-5 and Table 6-6. Table 6-5 and Table 6-6 note what water quality monitoring sites are currently being monitored, and the current monitoring sites are displayed on Figure 6-7.

Table 6-5 Twin Metals Minnesota, LLC Controlled Surface Water Monitoring Station Locations

Station Identification	TMM Stations Currently Being Monitored	Drainage Area (square miles)	Years of Flow Data	Years of Water Quality Data	Years of Stream Morphology Assessment	Years of Stage Elevation Data	Location Description
DMSW1	No	9.8	2008-2009	2008-2013	not collected	not collected	Filson Creek on County Highway 16
DMSW2	No	690.2	not collected	2008-2013	not collected	not collected	South Kawishiwi River upstream of the confluence with Filson Creek
DMSW3	Yes	2.7	2008-2013, 2017-current	2008-2013, 2017-current	not collected	2017-2018	North Nokomis Creek (Kittle Number: H-001-092-017.4)
DMSW4	Yes	54.5	not collected	2008-2015, 2017-current	not collected	not collected	Dunka River
DMSW5	No	2.9	2008-2013	2008-2013	not collected	not collected	Unnamed Creek near Bob Bay
DMSW6	No	10.4	2008-2010	2008-2010	not collected	not collected	Unnamed Creek, tributary to the Dunka River, at County Road 623
DMSW7	No	43.2	not collected	2008-2013	not collected	not collected	Dunka River upstream at Forest Road 424
DMSW8	No	208.2	2014-2016	2008-2013	not collected	not collected	Stony River at Forest Road 424
DMSW9	No	37.1	not collected	2008-2013	not collected	not collected	Birch Lake west of Bob Bay
DMSW10	No	0.1	2008-2013	2008-2013	not collected	not collected	Flamingo Creek
DMSW11	No	111.6	not collected	2008-2013	not collected	not collected	Birch Lake north of Bob Bay
DMSW12	Yes	1089.8	not collected	2008-current	not collected	not collected	At the Birch Lake outlet
DMSW13	Yes	707.7	not collected	2008-current	not collected	not collected	South Kawishiwi River at Highway 1
DMSW14	No	1115.8	not collected	2009-2013	not collected	not collected	White Iron Lake reservoir
DMSW15	Yes	10.6	not collected	2010-2013, 2017-current	not collected	not collected	Keeley Creek
DMSW16	Yes	14.9	2014-current	2010-2013	not collected	not collected	Denley Creek
DMSW17	Yes	236.2	not collected	2010-current	not collected	not collected	Stony River near its mouth to Birch Lake
DMSW18	No	3.0	not collected	2011-2013	not collected	not collected	Bob Bay
DMSW19	No	27.5	not collected	2012-2013	not collected	not collected	Birch River
DMSW20	Yes	371.5	not collected	2012-2013, 2017-current	not collected	not collected	Birch Lake
DMSW21	No	68.0	not collected	2012-2013	not collected	not collected	Bear Island River
DMSW22	No	1149.3	not collected	2012-2013	not collected	not collected	Garden Lake
DMSW23	No	10.3	not collected	2012-2013	not collected	not collected	Filson Creek, downstream of DMSW1
DMSW24	No	2.3	2014-2016	2012-2016	not collected	not collected	Kangas Creek
DMSW25	No	1.4	not collected	2012-2013	not collected	not collected	Unnamed Creek
DMSW26	No	0.4	not collected	2012-2013	not collected	not collected	Unnamed Creek
DMSW27	No	0.9	2014-2016	2012-2016	not collected	not collected	Unnamed Creek at the north end of Birch Lake
FR-1	No	110.0	not collected	2007-2008	not collected	not collected	Birch Lake
FR-2	No	2.9	2007	2007-2008	not collected	not collected	Mouth of Unnamed Creek where it enters into Bob Bay
FR-3	No	3.0	not collected	2007-2008	not collected	not collected	Bob Bay
FR-4	No	371.5	not collected	2007	not collected	not collected	Birch Lake
FR-5	No	707.4	not collected	2007-2008	not collected	not collected	South Kawishiwi River
FR-6	No	1089.8	not collected	2007-2008	not collected	not collected	South Kawishiwi River
FR-7	No	354.9	not collected	2007-2008	not collected	not collected	Birch Lake
FR-8	No	3.1	not collected	2007-2008	not collected	not collected	Unnamed Stream
FR-9	No	0.1	not collected	2008	not collected	not collected	Unnamed Creek near Scott Road, Babbitt
FR-10	No	55.1	not collected	2008	not collected	not collected	Dunka River, 3000 feet upstream of Birch Lake
FR-11	No	1100.4	not collected	2008	not collected	not collected	White Iron Lake
FR-12	No	236.2	not collected	2008	not collected	not collected	Stony Creek at its mouth
FR-13	No	34.2	not collected	2008	not collected	not collected	Birch Lake north of Babbitt

Station Identification	TMM Stations Currently Being Monitored	Drainage Area (square miles)	Years of Flow Data	Years of Water Quality Data	Years of Stream Morphology Assessment	Years of Stage Elevation Data	Location Description
FR-14	No	0.7	not collected	2008	not collected	not collected	Unnamed Creek, a tributary to the Stony River, near Forest Route 178
SW28	Yes	0.2	not collected	2017-current	not collected	not collected	South Nokomis Creek (Kittle Number: H-001-092-017.2)
SW29	Yes	0.4	2017-current	not collected	not collected	2017-2018	South Nokomis Creek (Kittle Number: H-001-092-017.2) at the culvert
DMSM1	No	9.8	not collected	not collected	2008	not collected	Filson Creek on County Highway 16
DMSM3	No	2.5	not collected	not collected	2008	not collected	North Nokomis Creek (Kittle Number: H-001-092-017.4)
DMSM4	No	55.6	not collected	not collected	2008	not collected	Dunka River, close to its mouth
DMSM5	No	2.9	not collected	not collected	2008	not collected	Unnamed Creek near Bob Bay
DMSM10	No	0.2	not collected	not collected	2008	not collected	Flamingo Creek
DMSM21	No	0.2	not collected	not collected	2008	not collected	South Nokomis Creek (Kittle Number: H-001-092-017.2)
DMSM22	No	54.8	not collected	not collected	2008	not collected	Dunka River, upstream of Birch Lake

Table 6-6 Government Controlled Surface Water Monitoring Station Locations

Station Identification	Drainage Area (square miles)	Years of Flow Data	Years of Water Quality Data	Years of Stream Morphology Assessment	Years of Stage Elevation Data	Location Description
SD-001	43.8	not collected	2008-2013	not collected	not collected	Pit dewatering discharge into Dunka River
SD-005	0.1	not collected	2007-2013	not collected	not collected	Seepage treatment monitoring site east of Dunka Pit
SD-006	0.1	not collected	2007-2013	not collected	not collected	Seepage treatment monitoring site northeast of Dunka Pit
SD-007	0.1	not collected	2007-2013	not collected	not collected	Seepage treatment monitoring site east of Dunka Pit
SD-008	1.2	not collected	2007-2013	not collected	not collected	Seepage treatment monitoring site east of Dunka Pit
SD-009	1.1	not collected	2007-2013	not collected	not collected	Seepage treatment monitoring site east of Dunka Pit
SW-001	2.8	not collected	2007-2013	not collected	not collected	Unnamed Creek close to Bob Bay
WS-001	0.0	not collected	2007-2013	not collected	not collected	Seepage treatment monitoring site east of Dunka Pit
WS-003	0.1	not collected	2007-2013	not collected	not collected	Seepage monitoring site east of Dunka Pit
WS-004	1.1	not collected	2007-2013	not collected	not collected	Seepage monitoring site east of Dunka Pit
WS-005	0.0	not collected	2007-2013	not collected	not collected	Seepage monitoring site east of Dunka Pit
USGS 05125000 / MDNR 72065001	442	1951-1961, 1976-1978, 2003-current	not collected	not collected	1951-1961, 1976-1978, 2003-current	South Kawishiwi River upstream of Birch Lake
USGS 05126210 / MDNR 72065002	837	1975-1978, 2003-current	not collected	not collected	1975-1978, 2003-current	South Kawishiwi River downstream of Birch Lake
USGS 05126000 / MDNR 72047001	57	1951-1962, 1975-1980, 2011-current	not collected	not collected	1951-1962, 1975-1980, 2011-current	Dunka River
USGS 05125550 / MDNR 72045001	211	1975-1980, 2014-current	not collected	not collected	1975-1980, 2014-current	Stony River
USGS 05124990 / MDNR 72032001	10	1974-1985, 2009-current	not collected	not collected	1974-1985, 2009-current	Filson Creek

Notes:
Government controlled stations are any station that is controlled by the MDNR, USGS, or by both.

Publicly Available Data

USGS stream flow data is available for several gauging stations in the vicinity of the Project area. The period of record ranges from 1951 to the present; however, none of the gauging station records cover the full period. Additionally, lake stage has been recorded daily at Birch Lake and White Iron Lake.

A long water quality record exists for the USGS station at the South Kawishiwi River, which was sampled monthly from 1966 to 1970 and quarterly until 1995.

Site-Specific Data

Surface water baseline hydrology and water quality in the vicinity of the Project area has been characterized through targeted investigations since 2007. The Project surface water monitoring network includes both flow and water quality monitoring sites. The number of monitoring sites and frequency of monitoring has been refined as the Project has evolved.

Stream flow monitoring has been conducted in Filson Creek, North Nokomis Creek, Stony River, Flamingo Creek, Denley Creek, Kangas Creek, and three Unnamed Creeks. Streamflow monitoring stations and monitoring periods are listed in Table 6-5 and Table 6-6.

The Project surface water monitoring program has also included water quality sampling. Initial water quality sample locations were focused on Birch Lake, major streams draining to Birch Lake, and streams near the Dunka Pit. Two locations on Filson Creek and the South Kawishiwi River upstream of the underground mine area were also included. The number of sampling locations expanded between 2008 and 2012 and ultimately included 26 sampling locations numbered DMSW1 through DMSW27 (DMSW6 was deleted from the program when a discharge from the Peter Mitchell Pit was terminated and the drainage dried up). Surface water quality monitoring stations and monitoring periods are listed in Table 6-5 and Table 6-6.

In addition to the Project-specific water quality monitoring stations, 11 water quality stations were monitored from 2007 through 2013 in the vicinity of the Dunka Pit as part of the Cliffs Erie National Pollutant Discharge Elimination System permit. These locations are listed in Table 6-5 and Table 6-6 and shown on Figure 6-6.

Parameters monitored as part of the Project surface water quality program have varied across both monitoring locations and monitoring events. In general, monitored parameters have included field measured parameters such as pH and temperature; general parameters such as alkalinity, chloride, and sulfate; nutrients such as nitrogen and phosphorus; and metals such as aluminum, copper, and mercury.

In addition to site-specific flow and surface water quality data, TMM has also conducted stream morphology surveys, as described in the section *Stream Morphology*.

6.1.1.3 Hydrology

This section describes stream flow, stream morphology, and water levels in Birch Lake.

The general hydrologic regime in the vicinity of the Project consists of a relatively thin, discontinuous, layer of quaternary unconsolidated materials (QUM) overlying relatively impermeable bedrock. Precipitation runs off into surface water bodies or recharges groundwater in the QUM. Groundwater from the QUM primarily discharges to streams, lakes, reservoirs, and wetlands in the area.

Stream Flow

Generally, stream flow can be divided into two components. The first is event flow, which is water that enters streams promptly in response to individual water-input events (rain or snow melt). The second is base flow, which is water that enters from persistent, slowly varying sources and maintains streamflow between water-input events. It is typically assumed that most, if not all, base flow is supplied by groundwater circulation in the drainage basin; however, base flow may also be supplied by drainage of lakes or wetlands (Dingman, 2002). In the Project area, the groundwater contribution is primarily a function of the more permeable unconsolidated deposits overlying relatively impermeable bedrock redistributing precipitation to surface water features.

Table 6-7 presents average, minimum, and maximum stream flows over the period of record for eight gauging stations in the vicinity of the Project area: five USGS / MDNR stations and three Project-specific stations currently being monitored. Generally, stream flow follows a seasonal pattern, with peak flows in the spring and low flow in the winter. Magnitude of flow varies widely with stream size with the highest flows measured in the South Kawishiwi River and the lowest flows in North Nokomis Creek and South Nokomis Creek.

Table 6-7 Stream Flow Summary

Station Name	General Station Location	Data Summary Period	Drainage Area (mi^2)	Average Flow (cfs)	Minimum Flow (cfs)	Maximum Flow (cfs)
USGS 05125000 / MDNR 72065001	South Kawishiwi River upstream of Birch Lake	1951-1961, 1976-1978, 2003-2018	442	420	17	5,110
USGS 05126210 / MDNR 72065002	South Kawishiwi River downstream of Birch Lake	1975-1978, 2003-2018	837	689	27	8,040
USGS 05126000 / MDNR 72047001	Dunka River	1951-1962, 1975-1980, 2011-2018	57	39	0	828
USGS 05125550 / MDNR 72045001	Stony River	1975-1980, 2014-2018	211	178	0	2,460
USGS 05124990 / MDNR 72032001	Filson Creek	1974-1985, 2009-2018	10	7	0	324
DMSW3	North Nokomis Creek (Kittle Number: H-001-092-017.4)	2008-2013, 2017-2018	2.79	3	0.4	9
DMSW16	Denley Creek	2014-2018	15.12	12	2	31
SW29	South Nokomis Creek (Kittle Number: H-001-092-017.2) at the culvert	2017-2018	0.46	0.4	0	1.5

Notes:
Average, minimum, and maximum flow calculated using all data available as summarized under the data summary period column.
Abbreviations:
cfs = cubic feet per second
mi^2 = square miles

Base flow data were analyzed for rivers in the vicinity of the Project area using USGS / MDNR gauging station data for the South Kawishiwi River and Dunka River. A computer program called PART, developed by the USGS, was used to estimate average groundwater discharge under the most recent continuous stream flow daily record. The analysis is a preliminary step to characterize base flow and was only conducted for the locations that had daily record data sets available over the last five years (2014 through 2018) with minimal data gaps. Table 6-8 provides the results of the analysis. As additional data becomes available base flow will be further analyzed.

Table 6-8 Base Flow Estimates from PART Analysis

Station Name	General Station Location	Drainage Area (mi^2)	Time Period[3]	Mean Daily Streamflow (cfs)	Mean Daily Baseflow (cfs)
USGS 05125000 / MDNR 72065001[1]	South Kawishiwi River upstream of Birch Lake	442.0	2014-2018	481.8	437.2
USGS 05126210 / MDNR 72065002	South Kawishiwi River downstream of Birch Lake	837.0	2014-2018	815.0	705.3
USGS 05126000 / MDNR 72047001[2]	Dunka River	57.0	2014-2018	41.5	35.4

Notes:
[1] Flow data was estimated for 12/27/2018 through 12/31/2018 to complete dataset for 2018. The 12/26/2018 flow rate was used for all of these dates.
[2] Flow data was estimated for 5/8/2018 using value from previous day. Flow data was estimated for 8/10/2018 to 8/13/2018 using flow data from 8/9/2018.
[3] The time period for each station contains 1,826 mean daily streamflow values.
Abbreviations:
cfs = cubic feet per second
mi^2 = square miles

These initial base flow results (Table 6-8) indicate that groundwater baseflow provides approximately 85% to 90% of the stream flows. The conceptual model is that baseflow is routed through the unconsolidated materials above the bedrock due to the impermeable nature of the bedrock and topography of the bedrock surface. In the South Kawishiwi River, downstream of the Birch Lake dam (Station USGS 0512610 / MDNR 72065002), where releases from the dam provide both event flow and continued base flow as release from Birch Lake storage, the preliminary base flow analysis indicates there is also a likely base flow component from unconsolidated deposit groundwater. Examination of the annual hydrographs for these streams also indicates large peaks in flow during the spring snow melt. Many of the wetland areas in the vicinity of the Project area may have a dampening effect on runoff from storm events.

The stream flow data available for DMSW3, DMSW16, and SW29 monitoring locations was not usable for the analytical base flow analysis because the measurements were not recorded frequently enough to define the response to an individual storm event. Additional analysis of base flow for these streams will be conducted as information becomes available. However, as presented in Table 6-7, all eight streams in the vicinity of the Project area generally maintain at least a small amount of flow during low flow periods indicating a component of base flow from shallow groundwater contributions, from the thin unconsolidated materials above the bedrock.

Stream Morphology

A stream morphology assessment was conducted in the summer of 2008 at seven sites identified on Figure 6-6 and summarized in Table 6-5 and Table 6-6. Entrenchment ratio, bankfull width-depth ratio, sinuosity, and the number of channels for the stream (braided versus non-braided channels) was used to classify each stream into one of seven stream types (Rosgen, 1994). Each stream type shares some core characteristics and streams within each type often behave in similar ways. Therefore, the Rosgen classification system provides a reasonable starting point for evaluating each stream (Rosgen, 1994). All seven sites assessed were either Type E or Type C streams as summarized below:

- Rosgen Classification Type E
    - DMSM1 – Filson Creek
    - DMSM3 – North Nokomis Creek (Kittle Number: H-001-092-017.4)
    - DMSM21 – South Nokomis Creek (Kittle Number: H-001-092-017.2)
    - DMSM5 – Unnamed Creek
    - DMSM10 – Flamingo Creek
- Rosgen Classification Type C
    - DMSM4 – Dunka River
    - DMSM22 – Dunka River

Type E streams are typically stable streams and are not in the process of a channel evolution. They typically have low width-depth ratios (<12); are slightly entrenched (entrenchment ratio >2.2), and high sinuosity (> 1.5). The riparian vegetation is often dominated by grasses and shrubs.

Type C streams are also typically stable streams not in the process of channel evolution. They typically have moderate to high width-depth ratios (>12); are slightly entrenched (entrenchment ratio >2.2), and moderate to high sinuosity (>1.2). Type C streams often have point bars on the inside bank of a meander and a relatively low stream slope. The vegetation is often dominated by woody trees and shrubs.

Birch Lake Water Level

Birch Lake water level is at an elevation of roughly 1,414 ft (431 m) amsl. The water level on Birch Lake is controlled by a dam operated by Minnesota Power at the northern most end of the lake where it drains into White Iron Lake through the South Kawishiwi River. Water levels are controlled based on water management needs of the Winton Hydroelectric Station at the north end of Garden Lake. Dam operation results in a winter drawdown of about 4 ft.

The *MDNR LakeFinder* (MDNR, 2019b) data identifies Birch Lake as having a recorded water level range of 5.7 ft (1.7 m).

6.1.1.4 Surface Water Quality

This section provides an overview of regional surface water quality, identifies impaired waters in the Project vicinity, and describes site specific surface water quality.

Regional Surface Water Quality

The Project would be located in a region composed of forests, marshes, and wetlands. Surface water quality is generally considered good, with dilute cation / anion concentrations and broadly characterized as a calcium-bicarbonate type water with generally low turbidity, low TSS, and neutral pH (7.2 to 8.3) (MPCA, 2017).

Generally, the data demonstrate stream water quality at the South Kawishiwi River is weakly buffered, with dilute cations / anions, exhibiting fairly low specific conductance ranging between 19 to 50 microSiemens per centimeter (µS/cm), and alkalinity between 120 and 320 milliequivalents per liter. Like many rivers in the region, the South Kawishiwi River is tea-colored due to high tannins, or incompletely dissolved organic materials. Water type is calcium-magnesium-bicarbonate type, likely due to the influence of geology and weathering of primary minerals, including calcium-rich plagioclase and pyroxene minerals. (Mast and Turk, 1999).

Streams in the vicinity of the Project area contain soft water with low alkalinity, low total dissolved solids (TDS), low nutrients, high color, very low trace metals concentrations and low fecal coliform counts (EQB, 1979). Relative to other streams, nutrient concentrations (i.e., phosphorous and nitrogen) are low. Concentrations of copper, nickel, and zinc are very low within the region (generally 1 to 2 microgram per liter [µg/L]). Other trace metals of biological importance, including arsenic, cadmium, cobalt, mercury, and lead have median concentrations significantly below 1 µg/L (EQB, 1979).

In lakes, the overall concentrations of nutrients (phosphorous and nitrogen) is relatively low, though median values were higher south of the Laurentian Divide than north of it. The most productive lakes within the region are shallow headwater lakes, surrounded by extensive bog and marsh areas (EQB, 1979). Because lakes have a large surface area of bottom sediments and longer residence times, the chemistry of outflow water can differ from the inflow water with respect to trace metals concentrations. Large lakes, such as Birch Lake, also exhibit variability in concentration of metals.

While surface water quality is generally good (MPCA, 2017), the lakes in the region have been subject to human-induced environmental changes since European settlement of the region approximately 140 years ago (Reavie, 2013). Work to reconstruct past environmental conditions in the White Iron Chain of Lakes has shown anecdotal and measured evidence that indicates “several stressors are having detrimental impacts, or have the potential for negative effects, on the quality of this system” (Reavie, 2013). This is a result of treated and untreated domestic wastewater, and agricultural and urban runoff. Another historical human-induced water quality stressor in the area is erosion. This was a result of much of the watershed being deforested in the late 1800s through the early 1900s and is still an issue today with development of residential property and recreational motor boating (Reavie, 2013).

Impaired Waters

The draft 2020 MPCA 303d Impaired Water List includes four waters within 1 mile of the Project:

- Birch Lake (AUID 69-0003-00) for aquatic consumption-mercury in fish tissue (No TMDL, EPA category 5);
- Keeley Creek (AUID 09030001-520) for aquatic life, aluminum stressor (No TMDL, EPA category 4D);
- Filson Creek (AUID 09030001-605) for aquatic life, aluminum and copper stressors (No TMDL, EPA category 4D); and
- Unnamed Creek tributary to Filson Creek (AUID 09030001-983) for aquatic life, aluminum stressor (No TMDL, EPA category 4D).

Site-Specific Surface Water Quality

Project-specific surface water quality data collected in 2017 and 2018 is presented in Table 6-9 and Table 6-10 as averaged values. In general, surface water in the vicinity of the Project area can be characterized as magnesium-bicarbonate type, with three exceptions. The Birch Lake outlet (DMSW12) and the South Kawishiwi River (DMSW13) are calcium-bicarbonate type, and Keeley Creek (DMSW15) is characterized as magnesium-chloride type water. The water can be generally characterized as well-oxygenated, low turbidity, pH neutral, and low sulfate.

Table 6-9 Average Surface Water General Parameter Concentrations from Locations Measured in 2017 and 2018

Parameter	Units	DMSW12 Birch Lake	DMSW20, 0 ft Birch Lake	DMSW20-mid Birch Lake	DMSW20-deep Birch Lake	DMSW4 Dunka River	DMSW17 Stony River	DMSW13 South Kawishiwi River	DMSW3 North Nokomis Creek	DMSW15 Keeley Creek	SW28 South Nokomis Creek
Alkalinity, Total as $CaCO_3$	mg/L	25.2	26.1	27.5	26.8	49.6	26.0	20.7	3.0	10.3	21.5
Alkalinity, Bicarbonate ($CaCO_3$)	mg/L	25.2	26.1	27.5	26.8	49.6	26.0	20.7	3.0	10.3	21.5
Carbon, dissolved organic	mg/L	17.6	20.9	21.0	21.0	25.9	25.8	14.8	42.9	32.3	11.7
Carbon, total organic	mg/L	17.6	20.8	20.8	20.7	26.2	26.0	15.1	46.0	32.6	12.2
Chemical Oxygen Demand	mg/L	48.5	57.2	60.5	60.9	78.4	74.6	39.0	126.9	99.2	35.9
Chloride	mg/L	1.7	2.5	2.5	2.4	8.3	1.4	1.0	7.6	4.1	0.7
Chlorophyll a, pheophytin-adjusted	µg/L	3.40	3.43	4.25	3.40	NM	NM	3.90	NM	NM	NM
Dissolved oxygen	mg/L	9.9	9.6	9.0	9.0	9.6	10.4	9.9	9.2	9.5	5.7
Fluoride	mg/L	0.079	0.073	0.073	0.071	0.082	0.073	0.085	0.041	0.026	0.041
Hardness, as $CaCO_3$	mg/L	31.7	35.6	36.0	35.3	62.9	33.3	24.6	19.3	19.6	21.5
Nitrogen, ammonia, as N	mg/L	0.055	0.063	0.060	0.065	0.122	0.081	0.056	0.172	0.606	0.074
Nitrogen, NO_3 + NO_2	mg/L	0.053	0.049	0.051	0.066	0.106	0.075	0.056	0.017	0.033	0.020
pH	s.u.	7.2	7.4	7.2	7.0	6.9	6.9	7.3	5.9	6.1	6.4
Phosphorus as P	mg/L	0.019	0.021	0.020	0.022	0.027	0.021	0.017	0.025	0.033	0.043
Redox (oxidation potential)	mV	181.9	153.8	155.5	177.6	141.4	106.2	153.0	205.0	153.9	164.1
Solids, total dissolved	mg/L	60.4	69.8	99.3	84.0	149.8	77.4	55.2	99.4	95.8	52.6
Solids, total suspended	mg/L	1.6	2.3	2.1	2.1	3.7	1.8	1.8	4.6	5.1	6.9
Specific Conductance	µS/cm@25 C	67.5	75.9	75.2	75.7	162.1	64.6	52.4	55.9	48.6	49.8
Sulfate, as SO_4	mg/L	3.6	5.3	5.3	5.1	16.4	0.8	1.6	0.2	0.3	0.1
Temperature	deg C	14.7	15.8	15.6	15.3	13.6	17.2	15.4	10.4	13.1	14.3
Turbidity	NTU	1.5	1.1	1.1	2.3	2.9	2.2	2.1	2.2	3.2	3.1

Notes:
Average concentrations of five sampling events in 2017 and 2018; DMSW20 averages only four sampling events because it was not sampled in May 2018.
DMSW20-mid, sampled at depths of 3 ft on 7/26/17, 8 ft on 10/16/17, and 8 ft on 8/13/18 and 10/12/18.
DMSW20-deep, sampled at depths of 6 ft on 7/26/17, 17.7 ft on 10/16/17, and 15 ft on 8/13/18 and 10/12/18.
Non-detects were set equal to 0 for average calculations presented in this table. This methodology will be reviewed and modified, as needed, during environmental review. ND is reported when all results for a particular parameter and location were non-detectable.
Decimal formatting is generally in alignment with laboratory analytical reporting.
Abbreviations:
µg/L = micrograms per liter
µS/cm@25 C = microSiemens/centimeter at 25 degrees Celsius
deg C = degrees in Celsius
mg/L = milligrams per liter
mV = millivolts
NM = not measured
NTU = nephelometric turbidity units
s.u. = standard units

Table 6-10 Average Surface Water Total Metals Concentrations from Locations Measured in 2017 and 2018

Parameter	Units	DMSW12 Birch Lake	DMSW20, 0 ft Birch Lake	DMSW20-mid Birch Lake	DMSW20-deep Birch Lake	DMSW4 Dunka River	DMSW17 Stony River	DMSW13 South Kawishiwi River	DMSW3 North Nokomis Creek	DMSW15 Keeley Creek	SW28 South Nokomis Creek
Aluminum	µg/L	109.1	140.0	140.5	142.3	142.2	189.6	89.0	347.2	354.0	30.0
Antimony	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	µg/L	0.30	0.58	0.49	0.44	0.58	0.58	0.26	0.88	0.58	0.31
Barium	µg/L	5.1	6.3	6.2	6.2	8.1	5.1	4.0	8.1	7.0	11.7
Beryllium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	µg/L	5.5	13.5	13.8	7.9	76.2	2.9	2.6	1.0	1.2	1.2
Cadmium	µg/L	0.028	0.110	0.088	ND	0.026	ND	ND	0.034	ND	ND
Calcium	µg/L	6440	6900	6925	6850	11460	6160	5680	3348	3440	4100
Chromium	µg/L	0.29	0.27	0.24	0.25	0.23	0.46	0.26	1.10	0.88	0.21
Cobalt	µg/L	0.14	0.26	0.24	0.17	0.59	0.23	0.08	1.87	2.77	0.63
Copper	µg/L	1.5	1.5	1.5	1.5	1.2	1.3	1.9	1.0	1.5	1.1
Iron	µg/L	773	895	899	910	2574	1241	625	2768	2588	2968
Lead	µg/L	0.17	0.29	0.28	0.21	0.14	0.26	0.13	0.50	0.31	0.01
Magnesium	µg/L	3780	4450	4525	4425	8320	4320	2560	2642	2700	2740
Manganese	µg/L	34.1	36.8	38.1	40.0	216.1	66.9	28.0	110.1	202.2	148.4
Mercury	ng/L	3.10	3.78	3.56	3.70	5.74	5.04	2.86	4.17	6.05	1.26
Molybdenum	µg/L	0.15	0.24	0.24	0.24	0.98	0.12	0.08	0.04	0.01	0.01
Nickel	µg/L	1.6	2.4	2.3	2.2	1.7	1.1	1.0	3.9	3.9	2.6
Potassium	µg/L	308	405	400	318	1090	210	198	228	130	652
Selenium	µg/L	0.04	0.16	0.18	0.09	0.13	0.12	0.08	0.20	0.04	0.04
Silver	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	µg/L	2040	2475	2500	2425	8660	1660	1620	4674	3240	1190
Strontium	µg/L	26.8	33.3	33.7	32.2	81.7	19.8	21.2	15.8	16.3	25.6
Thallium	µg/L	0.0013	0.0025	0.0023	0.0021	0.0016	0.0018	0.0011	0.0041	0.0039	0.0006
Zinc	µg/L	2.37	1.88	2.15	1.85	4.06	7.68	1.30	4.80	3.78	1.96

Notes:
Average concentrations of five sampling events in 2017 and 2018; DMSW20 averages only four sampling events because it was not sampled in May 2018.
DMSW20-mid, sampled at depths of 3 ft on 7/26/17, 8 ft on 10/16/17, and 8 ft on 8/13/18 and 10/12/18.
DMSW20-deep, sampled at depths of 6 ft on 7/26/17, 17.7 ft on 10/16/17, and 15 ft on 8/13/18 and 10/12/18.
Non-detects were set equal to 0 for average calculations presented in this table. This methodology will be reviewed and modified, as needed, during environmental review. ND is reported when all results for a particular parameter and location were non-detectable.
Decimal formatting is generally in alignment with laboratory analytical reporting.
Abbreviations:
µg/L = micrograms per liter
ND = non-detectable
ng/L = nanograms per liter
NM = not measured

Average copper, nickel, and zinc concentrations range from approximately 1 to 8 µg/L. Average concentrations of other trace metals of biological importance, including arsenic, cadmium, cobalt, and lead range from non-detectable to <3 µg/L. All locations exhibited average mercury concentrations below 6.05 nanograms per liter, the highest average measured at Keeley Creek (DMSW15). These average metal concentrations are generally similar to what was reported within the *Minnesota Regional Copper-Nickel Study* (EQB, 1979). Average aluminum concentrations generally ranged from 100 to 200 µg/L, with two high outliers at Keeley Creek (DMSW15) and at North Nokomis Creek (DMSW3) (Kittle Number: H-001-092-017.4) where average aluminum concentrations were approximately 350 µg/L. The aluminum concentration at South Nokomis Creek (SW28) (Kittle Number: H-001-092-017.2) was lower than the other locations with an average of 30 milligrams per liter (mg/L).

Surface water quality in creeks (North Nokomis Creek (Kittle Number: H-001-092-017.4), South Nokomis Creek (Kittle Number: H-001-092-017.2), and Keeley Creek) showed higher overall variability than lakes and rivers, with typically higher average concentrations for salts and metals at North Nokomis Creek (Kittle Number: H-001-092-017.4) and lower average concentrations at South Nokomis Creek (Kittle Number: H-001-092-017.2). The pH of the creeks was circumneutral to slightly acidic, ranging from 5.9 to 6.4. Redox (reduction / oxidation potential) of creeks was on average higher than the lakes and rivers. Average alkalinity ranged from approximately 3 to 22 mg/L between the creek sites, while hardness was generally similar close to 20 mg/L. Copper concentrations in all three creeks was similar and low, near 1 µg/L, while nickel concentrations ranged from 2.6 µg/L to 3.9 µg/L. Concentrations of aluminum were most variable, and averages ranged tenfold from 30 to 354 µg/L. Average sulfate concentration within the creeks was low relative to rivers and lakes, with the highest average concentration at 0.3 mg/L. The creeks had higher average turbidity and higher TSS than rivers and lakes.

Surface water quality in rivers (Dunka River, Stony River, and South Kawishiwi River) exhibited circumneutral pH with values ranging from 6.9 to 7.3, and comparable redox and dissolved oxygen concentrations. In general, the Dunka River stands apart from the Stony River and the South Kawishiwi River because its water is roughly twice as hard as the other two rivers (approximately 60 mg/L vs 30 mg/L). In addition to having a higher concentration of some metals, the Dunka River also has average salt concentrations that are elevated relative to the other rivers. For example, average sulfate concentration at Dunka River was 16.4 mg/L, and average chloride concentration was 8.3 mg/L, while other river sites had concentrations close to 1 to 1.5 mg/L for both parameters. The Dunka River also had higher average turbidity, TSS, and alkalinity than the other rivers.

Birch Lake water quality was sampled at two locations, in 2017 to 2018, one at the outlet and one near the center. The center location (DMSW20) was sampled at various depths. Average concentrations of many parameters were similar between the two locations at the surface, including alkalinity, chloride, dissolved oxygen, and nutrients such as phosphorus and nitrogen. At DMSW20, pH decreases with depth from 7.4 at the top to 7.0 at lower lake depths, while measured redox potential increases. These changes in redox and pH exert some control on metals concentrations and average nickel, copper, and lead concentrations decreased slightly from the surface to the bottom of the lake. Aluminum concentrations exhibited the opposite pattern, with concentrations slightly increasing with depth. Sulfate concentrations in Birch Lake were constant, between 5.1 µg/L and 5.3 µg/L, with lower concentrations of 3.6 µg/L at the outlet.

6.1.2 <u>Groundwater</u>

This section identifies the hydrogeologic units (HGU) in the vicinity of the Project area, describes the available hydrogeologic data sources, summarizes baseline hydrogeologic characteristics and groundwater quality, and identifies groundwater use in the vicinity of the Project area.

6.1.2.1 Hydrogeologic Units in the Vicinity of the Project Area

HGU are groupings of geologic materials that have similar hydrogeologic properties and offer a degree of continuity across a project or regional area. Using field methods and associated interpretations of data the following HGUs have been defined for the Project area:

- QUM – The QUM includes soil, alluvial deposits, peat, and glacial deposits from ground surface to the top of bedrock, generally a thickness of 0 (where bedrock occurs as an outcrop) to 50 ft (15.2 m);
- Shallow Bedrock - Shallow bedrock is Duluth complex and GRB rock with low permeability, from the top of bedrock to a depth of approximately 300 ft (91.4 m) below the top of bedrock. Shallow bedrock is differentiated from deep bedrock by higher relative fracture density. In areas near the BMZ outcrop, the BMZ can be considered shallow bedrock; and
- Deep Bedrock – Deep bedrock is Duluth complex rock with very low permeability (lower relative fracture density) that extends from approximately 300 ft (91.4 m) below the top of bedrock to the top of the GRB. Deep bedrock includes the BMZ in down dip locations.
- A conceptualization of the defined HGUs is shown on Figure 6-8, and the characteristics of the HGUs are detailed in the section *Characteristics of Hydrogeologic Units*.

6.1.2.2 Data Sources

While some public hydrogeologic data is available, most of the hydrogeologic data about the Project area has been obtained by TMM through targeted, site-specific investigations since 2008.

<u>Publicly Available Data</u>

Groundwater has been evaluated dating back to 1965.

<u>Site-Specific Data</u>

Field investigations by TMM have included various down-hole geophysical testing of open exploration coreholes, installation of monitor wells, vibrating wire piezometers, and wetland piezometers, hydraulic conductivity testing, water level readings from the monitor well / piezometer network, and water quality sampling of the monitor well network.

Geophysical Testing

Geophysical testing has been conducted at selected existing exploration coreholes including acoustic televiewer photography of fractures in the corehole wall, down-hole hydrogeophysical logging, and discrete-interval inflatable packer testing. The goal of the geophysical testing has been to characterize the spatial and depth distribution of hydraulic conductivity within the bedrock.

TMM has conducted corehole hydrogeophysical testing at over 400 intervals in 74 coreholes located in the underground mine area. Field investigation activities conducted in exploration coreholes through 2018 are summarized in Table 6-11 through Table 6-21. Table 6-11 through Table 6-21 also summarize current work in progress (field testing and data analysis). Figure 6-9 shows the locations of coreholes that have been hydrologically tested.

Hydrogeophysical borehole logging testing methodology developed by Colog, Inc. has been employed to define flowing zones within the corehole and to focus further packer testing. For this method, the formation water in an open corehole is displaced with deionized water. Then, while pumping from the top of the water column at a low flow rate, the entire borehole is logged with an electrical conductivity and temperature probe. The electrical conductivity / temperature log identifies where groundwater from the geologic formation (with elevated salinity) has entered the corehole. Typically, pumping is continued, and two or three specific conductance logs are run at later times. For a particular zone producing groundwater, the multiple electrical conductivity logs show the migration of the salinity front in the borehole, which can be used to estimate the water production flow rate of the producing zone and define preferred test intervals. An example of a hydrogeophysical log is shown on Figure 6-10. The identified flow zones are then targeted for isolation via down–hole packers and testing is conducted at those discrete zones to estimate formation hydraulic conductivity. Standard aquifer test analysis was conducted, and the results of the geophysical testing were used to inform the hydrogeologic conceptual model, HGUs, and hydraulic conductivity distribution. Additional corehole testing is not anticipated at this time.

Table 6-11 2008 Core Hydrogeophysical Studies (BL Coreholes)

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Water levels, and short-term pumping tests in open exploration boreholes.	1	BL00-9B	B	B1, B2 and B4	0	1	WL to 75
Water levels, and short-term pumping tests in open exploration boreholes.	1	BL-062	B	B1, B2 and B4	0	1	WL to 85

Notes:
Single well pumping tests were performed in boreholes which were cased through overburden material, with open boreholes across shallow through deep bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-12 2008 Core Hydrogeophysical Studies (MEX Coreholes)

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-1	B	B1, B2 and B4	0	1	WL to 3975
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-33	B	B1, B2 and B4	0	1	WL to 1835
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-35	B	B1, B2 and B4	0	1	WL to 2609
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-50	B	B1, B2 and B4	0	1	WL to 3244
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-55	B	B1, B2 and B4	0	1	WL to 4193
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-61	B	B1, B2 and B4	0	1	WL to 3721
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-67	B	B1, B2 and B4	0	1	WL to 3478
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-107	B	B1, B2 and B4	0	1	WL to 3976
Water levels, water quality field parameters, and short-term pumping tests in open exploration boreholes.	1	MEX-109	B	B1, B2 and B4	0	1	WL to 3600

Notes:
Single well pumping tests were performed in boreholes which were cased through overburden material, with open boreholes across shallow through deep bedrock. Bedrock hydraulic conductivity values over these long test intervals were calculated to range from 1.1 x 10^{-7} cm/sec to 4.6 x 10^{-9} cm/sec.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-13 2012/2013 Core Hydrogeophysical Studies

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Water levels, slug tests, and packer tests in open exploration boreholes.	4	MEX-403	Q, B	Q2[1],B1, B2 and B4	1	3	9 to 1627
Water levels, slug tests, and packer tests in open exploration boreholes.	2	MEX-0342	B	B1, B2, B4	0	2	WL to 45
Water levels, slug tests, and packer tests in open exploration boreholes.	2	MEX-0349	B	B1, B2, B4	0	2	WL to 45
Water levels, slug tests, and packer tests in open exploration boreholes.	2	MEX-0384	B	B1, B2, B4	0	2	WL to 45
Water levels, slug tests, and packer tests in open exploration boreholes.	2	MEX-0395	B	B1, B2, B4	0	2	WL to 45
Water levels, slug tests, and packer tests in open exploration boreholes.	7	MEX-387	B	B1, B2, B4	0	7	19 to 1496
Water levels, slug tests, and packer tests in open exploration boreholes.	7	MEX-397	B	B1, B2, B4	0	7	38.5 to 1348
Water levels, slug tests, and packer tests in open exploration boreholes.	5	MEX-346	B	B1, B2, B4	0	5	213 to 1167
Water levels, slug tests, and packer tests in open exploration boreholes.	5	MEX-392	B	B1, B2, B4	0	5	53.5 to 1187
Water levels, slug tests, and packer tests in open exploration boreholes.	3	MEX-402	B	B1, B2, B4	0	3	300 to 1284

Notes:
Borehole packer tests were performed, primarily in bedrock. For test intervals less than 200 feet in total length, the hydraulic conductivities were observed to decrease with depth, ranging from 3.0×10^{-4} cm/sec in shallow bedrock to 1.6×10^{-6} cm/sec in deeper bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
[1] Testing is in long boreholes including the overburden Q material and extending into deep bedrock.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-14 2013 Core Hydrogeophysical Studies

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	18	MEX-227	Q, B	Q2[1],B1, B2 and B4	0	18	8.5 to 4086
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	16	MEX-244	Q, B	Q2[1],B1, B2 and B4	0	16	9.5 to 3748
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	13	MEX-249	Q, B	Q2[1],B1, B2 and B4	0	13	8.5 to 1748
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	12	MEX-257	Q, B	Q2[1],B1, B2 and B4	0	12	7 to 1457
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	12	MEX-313	B	B1, B2, B4	0	12	18.5 to 1229
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	15	MEX-319	Q, B	Q2[1],B1, B2 and B4	0	15	3.5 to 1328.5
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	20	MEX-321	Q, B	Q2[1],B1, B2 and B4	0	20	8.5 to 4586
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	12	MEX-323	B	B1, B2, B4	0	12	21.5 to 3909
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	11	BL10-2	B	B1, B2, B4	0	11	17.5 to 1655
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	21	BL10-4	Q, B	Q2[1],B1, B2 and B4	0	21	9 to 2892
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	20	BL 11-6	Q, B	Q2[1],B1, B2 and B4	0	20	8.5 to 3068
Water levels and slug tests in open exploration boreholes; 15-21 packer tests/hole.	2	MEX-0110M	Q, B	Q2[1],B1, B2 and B4	0	2	WL to 1479

Notes:
For test intervals less than 200 feet in total length, the hydraulic conductivities were observed to decrease with depth, ranging from 2.6 x 10^{-4} cm/sec in quaternary/shallow bedrock to 4.3 x 10^{-6} cm/sec in deeper bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
[1] Testing is in long boreholes including the overburden Q material and extending into deep bedrock.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-15 2015 Core Hydrogeophysical Studies (Straddle-packer Testing)

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Water levels, downhole geophysics and packer tests.	11	VWP-MN-545	B	B1,B2	0	11	40 to 468
Water levels, downhole geophysics and packer tests.	10	VWP-MN-546	B	B1,B2	0	10	22 to 775

Notes:
Hydraulic conductivities decrease with depth, from 1.5 x 10^{-4} cm/sec in shallow bedrock to 1.8 x 10^{-8} cm/sec in intermediate bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-16 2016 Core Hydrogeophysical Studies (Slug Testing)

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Geophysical logging and straddle-packer testing of four open exploration boreholes.	8	MEX-0001	B	B1, B2, B4	0	8	235 to 3975
Geophysical logging and straddle-packer testing of four open exploration boreholes.	8	MEX-0009	B	B1, B2, B4	0	8	68 to 2868
Geophysical logging and straddle-packer testing of four open exploration boreholes.	9	MEX-0011	B	B1, B2, B4	0	9	200 to 3148
Geophysical logging and straddle-packer testing of four open exploration boreholes.	8	MEX-0286	B	B1, B2, B4	0	8	158 to 2568

Notes:
No evidence of increased hydraulic conductivity or preferential groundwater flow associated with mapped structures. Hydraulic conductivities decrease with depth, from 1.0 x 10-5 cm/sec in shallow bedrock to 1.0 x 10^{-7} cm/sec in deep bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-17 2016 Core Hydrogeophysical Studies

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Slug tests and single-packer tests during the advancement of MEX-0496, near the confluence of the Kawishiwi River and Birch Lake, extending underneath Birch Lake.	8	MEX-0496	B	B1, B2 and B4	0	8	14.1 to 1252

Notes:
The Duluth complex hanging wall, hanging-basal mineralized zone contact, and basal mineralized zone-footwall contact are all characterized by low K values, 2×10^{-6} cm/sec or lower.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-18 2017 Core Hydrogeophysical Studies

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	3	MEX-0122M	B	B1, B2, B4	0	3	WL to 2059
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	5	MEX-0124	B	B1, B2, B4	0	5	WL to 4257
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	4	MEX-0125	B	B1, B2, B4	0	4	WL to 1831.2
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	3	MEX-0129	B	B1, B2, B4	0	3	WL to 3328
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	3	MEX-0130	B	B1, B2, B4	0	3	WL to 4202
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	5	MEX-0150	B	B1, B2, B4	0	5	WL to 1636.4
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	4	MEX-0165	B	B1, B2, B4	0	4	WL to 3747
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	4	MEX-0174	B	B1, B2, B4	0	4	WL to 4028
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	4	MEX-0203	B	B1, B2, B4	0	4	WL to 4419
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	3	MEX-0231	B	B1, B2, B4	0	3	WL to 3398
Geophysical logging and packer testing of eleven open exploration boreholes and one deep well.	3	MEX-0244	B	B1, B2, B4	0	3	WL to 3748

Notes:
Borehole packer tests were performed in bedrock. Although the majority of the test intervals were greater than 200 feet in length, the hydraulic conductivities decrease with depth, ranging from 1.0 x 10^{-5} cm/sec in shallow bedrock to less than 5.0 x 10^{-9} cm/sec (approaching the lower limit of equipment resolution) in deep bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-19 2018 Core Hydrogeophysical Studies (MEX Coreholes)

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0126	B	B1, B2, B4	0	4	WL to 3946.8
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0128	B	B1, B2, B4	0	4	WL to 2859
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0142	B	B1, B2, B4	0	4	WL to 3622.1
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0308	B	B1, B2, B4	0	4	WL to 3647
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	6	MEX-0341	B	B1, B2, B4	0	6	WL to 3248
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0351	B	B1, B2, B4	0	4	WL to 2879
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0353	B	B1, B2, B4	0	4	WL to 3275.5
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0358	B	B1, B2, B4	0	4	WL to 2948
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	4	MEX-0362	B	B1, B2, B4	0	4	WL to 3078
2018 Bedrock Hydrogeologic Results. Included packer testing at ten exploratory boreholes.	5	MEX-0369	B	B1, B2, B4	0	5	WL to 3068

Notes:
Borehole packer tests were performed in bedrock. For the test intervals were less than 200 feet in length, the hydraulic conductivities decrease with depth, ranging from 1.2 x 10-5 cm/sec in shallow bedrock to less than 3.6 x 10^{-7} cm/sec in deep bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-20 2018 Core Hydrogeophysical Studies (Wells)

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
HGP Addendum	4	MN-503B4	B	B4	0	4	33 to 316
HGP Addendum	6	MN-510B4	B	B4	0	6	WL to 2408.5
HGP Addendum	5	MN-544B4	B	B4	0	5	WL to 1541
HGP Addendum	5	MN-548B4	B	B4	0	5	WL to 1550

Notes:
Borehole packer tests were performed in bedrock, prior to installation of B4 monitoring wells. Hydraulic conductivities decreased with depth, from 1.1×10^{-5} cm/sec to 4.7×10^{-10} cm/sec in deep bedrock.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Table 6-21 2019 Core Hydrogeophysical Studies

Field Investigation	Total No. of Tests Performed	Test Corehole/ Well Name	Quaternary (Q) or Bedrock (B)	Hydrostratigraphic Unit	No. of Tests Performed in Quaternary	No. of Tests Performed in Bedrock	Test Interval (ft bgs)
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	4	MEX-0187	B	B1, B2, B4	0	4	WL to 4919
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	5	MEX-0200	B	B1, B2, B4	0	5	WL to 3957
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	3	MEX-0201	B	B1, B2, B4	0	3	WL-to 4639
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	4	MEX-0234	B	B1, B2, B4	0	4	WL to 3899
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	5	MEX-0240	B	B1, B2, B4	0	5	WL to 4238
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	5	MEX-0243	B	B1, B2, B4	0	5	WL to 3178
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	6	MEX-0294	B	B1, B2, B4	0	6	WL to 3197.5
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	5	MN-542B4	B	B1, B2, B4	0	5	WL to 1945
2019 Bedrock Hydrogeologic Results. Included packer testing at 7 exploratory boreholes and 2 B4 boreholes prior to well construction.	8	MN-507B4	B	B1, B2, B4	0	8	WL to 928

Notes:
Data collected, waiting on analysis.
Where available, the estimates of hydraulic conductivity from test intervals less than 200 feet in total length were used.
Abbreviations:
B = bedrock
B1 = shallow bedrock
B2 = intermediate bedrock
B4 = deep bedrock
bgs = below ground surface
cm/s = centimeters per second
ft = feet
HGP = Hydrogeophysics
K = hydraulic conductivity
Q = quaternary
WL = static water level

Monitor Well Network

Monitor wells and piezometers to facilitate testing, sample acquisition, and water level measurements have been installed in the vicinity of the underground mine area since 2014. The monitoring points were installed as "nested sites" with several wells installed at pre-determined discrete intervals at each drill pad to target the various HGUs. Targeted HGUs included the following:

- QUM HGU – Q1 piezometers and Q2 monitor wells.
  - Q1 Wells – Hand augered piezometers installed in wetland settings located as close to a well pad site as possible. These wells are intended to provide wetland water level data and are typically shallow (3 to 7 ft [0.9 to 2.1 m]) 2-inch steel installations; and
  - Q2 Wells – Sonic drilled monitor wells installed at the nested pad and screened in the QUM above the bedrock to intersect the water table. Q2 wells are constructed with 2-inch polyvinyl chloride (PVC) and terminate at the bedrock surface.
- Shallow Bedrock HGU – B1 and B2 monitor wells.
  - B1 Wells – isolate the top zone of 30 to 50 ft (9.14 to 15.2 m) into the competent shallow bedrock HGU. 2-inch PVC wells installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to approximately 40 to 50 ft (12.2 to 15.2 m) and isolating the well in competent bedrock (screened in the bottom approximately 20 ft [6.1 m] of bedrock); and
  - B2 Wells – isolate the zone of 100 to 150 ft (30.5 to 45.7 m) into the shallow bedrock HGU. 2-inch PVC wells installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to approximately 150 ft (45.7 m) and isolating the well in bedrock (screened in the bottom approximately 20 to 30 ft [6.1 to 9.1 m] of bedrock).
- Deep Bedrock HGU – B4 monitor wells
  - B4 Wells – 2-inch or 5-inch stainless steel wells installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to the approximate bottom of the BMZ (approximately 300 ft to 2,200 ft [91.4 m to 670.6 m] depending on location) and isolating the well in the BMZ (approximately 200 ft (61 m) of screen).
- Vibrating Wire Piezometers – Installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to selected intervals and setting pressure transducers at three discrete intervals.

Table 6-22 presents the correlation between monitor wells and HGUs and Table 6-23 summarizes the monitoring points installed to support the Project: 94 monitor wells and piezometers have been installed. Most are located in or near the underground mine area. Additional monitoring wells will be installed at the plant site and tailings management site as part of future scope. Figure 6-11 shows the existing monitor well locations.

Table 6-22 Summary of Hydrogeologic Units

HGU	Depth Range	Well	Depth Range	Monitoring Zone
QUM[1]	0-50 ft	Q1	~5 ft	Wetland Pz
QUM[1]	0-50 ft	Q2	0-50 ft	QUM MW
Shallow Bedrock[2]	0-350 ft	B1	50-100 ft	Shallow Bedrock
Shallow Bedrock[2]	0-350 ft	B2	120-170 ft	Shallow Bedrock
Deep Bedrock (BMZ)[3]	>300 ft	B4	0-2,300 ft	BMZ

Notes:
[1] QUM ends at the bedrock surface, which could be 0 to approximately 50 ft.
[2] Shallow bedrock starts at the termination of the QUM - could result in up to 350 ft total depth.
[3] BMZ is dependent on location due to dip and overburden thickness.
Abbreviations:
~ = approximately
BMZ = Basal Mining Zone
ft = feet
HGU = hydrogeologic units
MW = monitoring well
Pz = piezometer
QUM = quaternary unconsolidated materials

Table 6-23 Summary of Monitor Wells and Piezometers

Year	Q1 Piezometer	Q2 Monitor Wells	B1 Monitor Wells	B2 Monitor Wells	B4 Monitor Wells	Vibrating Wire Piezometer	TOTAL
2014	18	3	0	0	0	0	21
2015	0	0	0	0	0	2	2
2016	3	0	2	2	0	0	7
2017	0	0	2	2	0	0	4
2018	0	4	7	7	4	0	22
2019	9	7	10	10	2	0	38
TOTAL	30	14	21	21	6	2	94

Hydraulic Conductivity Testing in Monitor Wells

To define the hydraulic characteristics of the QUM and further define the hydraulic characteristics of the bedrock, all Q2, B1, B2, and B4 monitor wells were scheduled for aquifer testing. Aquifer testing was implemented in two steps:

1. Slug Testing – volume displacement within each well was implemented and the resulting water level response was recorded; and
2. Wells that exhibited the capability to produce enough groundwater based on drilling observations and slug test results were then pump tested. After a constant pumping rate was identified, each tested well was allowed to recover and then the constant rate was applied while measuring pumping

rate and water levels over time. At the end of the test, the pumping was terminated and the corresponding recovery was recorded.

Monitor well hydraulic conductivity testing is summarized in Table 6-24 and included 132 tests. Standard aquifer test analysis was conducted, and the results of the hydraulic conductivity testing programs were used to inform the hydrogeologic conceptual model, HGUs, and hydraulic conductivity distribution.

Table 6-24 Summary of Monitor Well Hydraulic Conductivity Testing

Year	Monitor Wells Slug Tested	Monitor Wells Pump Tested	TOTAL
2017	7	1	8
2018	21	19	40
2019	42	42	84
TOTAL	70	62	132

Groundwater Level Measurements

Each groundwater monitoring point has been surveyed to determine an elevation reference point. Monthly water level measurements are obtained by measuring the depth to groundwater from the surveyed measuring point. The water elevation data is used to determine groundwater flow direction, seasonal variation, response to precipitation trends, model calibration, and further inform the hydrogeologic model / HGU differentiation. Monthly water level data acquisition is anticipated to continue through the permitting process.

Groundwater Quality Sampling

Groundwater sampling commenced in the second quarter of 2018 and has been conducted on a quarterly basis at all available wells once they are constructed and adequately developed. Sample protocol included initial water level measurements, a pre-determined well purging methodology, field parameter data acquisition via an instrumented flow-through cell, sample preservation for laboratory analysis, and documentation. Table 6-25 summarizes the sample events conducted to date.

Table 6-25 Summary of Groundwater Quality Sample Acquisition

Event	Q2 Monitor Wells	B1 Monitor Wells	B2 Monitor Wells	B4 Monitor Wells	TOTAL
Q2 2018	3	7	3	0	13
Q3 2018	3	8	4	1	16
Q4 2018	5	11	7	1	24
Q1 2019	3	11	7	1	22
Q2 2019	5	11	9	1	26
TOTAL	19	48	30	4	101

Quarterly sampling of groundwater in different HGUs measures natural variations in groundwater quality over time. In addition to collection of field parameters, samples are preserved for laboratory analysis for select constituents. The groundwater results are currently being analyzed to determine baseline water quality, water types, and variation across the Project area.

Sampling is anticipated to continue with the sampling schedule to be determined. Sample results will be used to define baseline conditions and differentiate water quality types over space, time, and HGU.

Ongoing Groundwater Studies

In addition to the field efforts completed to date, ongoing sampling, monitoring, and testing activities continue including:

- Slug and pump testing of monitor wells installed in 2019;
- Monthly water level data acquisition; and
- Quarterly water quality sampling.

The tailings management site and the plant site the subjects of current investigative activities with additional monitor wells and associated testing / sampling planned for later 2019 / 2020.

The existing information base coupled with ongoing efforts are anticipated to yield results that would continue to allow the hydrogeologic system to be characterized to the degree necessary to define and address potential impacts to the hydrological regime and support the various permitting efforts associated with the Project. This characterization would provide data for assessing certain aspects of the Project as it pertains to engineering and environmental analysis including, but not limited to, the following:

- Definition of baseline hydrogeologic conditions;
- Estimation of groundwater inflows to the access decline and underground workings as they are developed;
- Definition of groundwater quality;
- Estimation of water level drawdowns in overburden and bedrock due to mine dewatering;
- Assessment of the re-saturated mine workings and mixing with adjacent groundwater analysis of effects associated with the dry stack facility; and
- Analysis of effects associated with the plant site.

6.1.2.3 Characteristics of Hydrogeologic Units

This section describes each of the HGUs, then presents site-specific hydraulic conductivity information and describes site–specific groundwater flow directions.

Description Hydrogeologic Units

Quaternary Unconsolidated Materials Hydrogeologic Units

The uppermost HGU in the Project area is the QUM. The QUM is made up of unconsolidated deposits including stream alluviums, peat, and glacial deposits consisting of outwash gravels, sands, silts, and clays. The QUM is laterally discontinuous with its thicknesses defined by the underlying bedrock surface topography. It ranges from zero thickness in areas of bedrock outcrop to approximately 50 ft (15.2 m) in areas of outwash and incised bedrock valleys. Sand and gravel deposits associated with glacial outwash are scattered throughout this region and are generally 10 to 30 ft (3.1 to 9.1 m) thick. Peat deposits have been accumulating since the ice retreated and may be a few feet thick up to 20 ft (6.1 m) thick. Individual layers of the materials tend to be laterally discontinuous and normally cannot be correlated between boreholes. An analysis of borehole data found that local QUM deposits generally ranged in thickness from 0.5 to 52 ft (0.2 to 13.1 m) with an average thickness of 10 ft (3.1 m).

The QUM usually contains a water table that roughly follows the ground surface topography, but that may locally be related to the geometry of the top of the bedrock surface (Ground Water Monitoring and Assessment Program [GWMAP], 1999). As a result, sand and gravel zones in glacial drift are the most favorable sources of groundwater in the region. However, the surrounding area has little groundwater development because the glacial drift is impermeable, thin, discontinuous, or absent (Ericson et al., 1976).

Shallow groundwater in the QUM in the vicinity of the Project area originates as recharge resulting from precipitation, raising the water table locally. A significant percentage of precipitation is consumed by vegetation (evapotranspiration) or intercepted by the QUM and drained toward surface water bodies (Ericson et al., 1976). Recharge has been estimated at 2.3 to 7.6 inches per year (Smith and Westenbroek, 2015). Wetland areas can intercept and reduce recharge to the QUM as most wetlands contain a lower layer of peat with very low hydraulic conductivity that restricts downward seepage Vertical downward infiltration is limited by the low-permeability of the bedrock units. Zones of low permeability till may produce locally confined conditions but generally the system is assumed to be unconfined

In general, groundwater flow in the QUM is slow because of the relatively low permeability of glacial till and peat, the relatively small hydraulic gradients, and because the flow system in the surficial materials is disrupted by outcrops of relatively impermeable bedrock (Siegel and Ericson, 1980).

In the Project vicinity, a portion of the shallow groundwater discharges to ponds, wetlands, and local streams, which connect to larger surface water features such as Filson Creek or Keeley Creek that direct surface water to the South Kawishiwi River or Birch Lake.

Groundwater flow directions in the Project area are generally towards Birch Lake to the west and the South Kawishiwi River to the north or other smaller surface water tributaries, as further described in the section *Site-Specific Groundwater Flow Direction*.

<u>Shallow Bedrock HGU</u>

The crystalline bedrock in the Duluth Complex has little to no primary porosity, but open fractures and fault rubble zones can provide secondary porosity that can convey groundwater (Siegel and Ericson, 1980). Fractures and joints in the Duluth Complex may extend to considerable depths but are more extensive in the upper 200 or 300 ft (61.0 or 91.4 m) (Siegel and Ericson, 1980). Overall, the shallow bedrock HGU has very low hydraulic conductivity. Potential recharge from precipitation greatly exceeds the bedrocks capacity to conduct water, resulting in most of the precipitation being routed to surface runoff and discharge / storage to lakes, streams, and wetland features.

Locally, the top few feet of the bedrock can exhibit enhanced weathering and alteration providing increased hydraulic conductivity in contrast to relatively unaltered bedrock a few feet deeper. In these areas, this weathered veneer is likely in direct contact and responds with the groundwater in the QUM.

The distinction between the shallow bedrock HGU and the deep bedrock HGU appears to be localized and depth-dependent rather than geological. The upper zone is locally composed of sub-horizontal fractures resulting in part from post glacial isostatic rebound. Three hundred feet of bedrock thickness is generally considered the limit of isostatic rebound forces associated with glaciation. Hydraulic conductivities have generally been found to be higher above 300 ft (91.4 m), and lower below 300 ft (91.4 m).

Fracture frequency is higher above approximately 300 ft (91.4 m) bgs, and a very low percentage of fractures have been observed to generate flow. Hydrogeophysical logging and packer testing demonstrate that approximately 1% of the total fractures convey groundwater flow. Hydrogeophysical logging suggests that groundwater flow tends to be concentrated in a relatively small number of discrete flow zones. It is typical when performing hydrogeophysical logging in a deep open corehole, that measurable flow is observed to come from two or three narrow zones, each typically <10 ft (3.1 m) thick. Most of the flow zones are in shallow bedrock associated with B1, although there are occasionally deeper flow zones. For 11 coreholes logged by hydrogeophysical in 2018, the total length of no-flow zones varied from approximately 80% to 98% of the total length of the hole. The average flow zone frequency is approximately 1.5 measurable fractures per 100 ft (30.6 m) above a depth of 300 ft (91.4 m). Below a depth of 300 ft (91.4 m), the flow zone frequency is significantly less.

Deep Bedrock HGU

Horizontal hydraulic conductivity in the deep bedrock HGU is the result of secondary porosity due to fracturing and faulting; the unfractured bedrock has little to no porosity (Siegel and Ericson, 1980). The probability of obtaining water from bedrock decreases with depth and is slight at depths >300 to 500 ft (91.4 to 152.4 m) below the top of bedrock (Ericson et al., 1976).

The transition from the shallow bedrock to the deep bedrock is not abrupt and has been estimated to occur at approximately 300 ft (91.4 m). The deep bedrock HGU includes bedrock >300 ft (91.4 m) in thickness and extends to the base of the Duluth Complex. The BMZ is generally present within the bottom of the deep bedrock HGU and represents the bottom of the Duluth Complex and the top of the GRB. This boundary also reflects the general lower limit of mining with the bottom of the BMZ serving as the foot wall.

The deep bedrock HGU is characterized by competent bedrock and low fracture density compared to the overlying bedrock HGUs. The average fracture flow zone frequency is approximately 0.5 measurable fractures per 100 ft (30.6 m) of vertical thickness in the depth range of 300 ft to 4,000 ft (91.4 to 1219.2 m) bgs. The transition within the deep bedrock HGU from augite troctolite to the BMZ is a distinct geologic and mineralogical boundary but hydraulically the BMZ and other deeper bedrock characteristics are similar.

Site-Specific Hydraulic Conductivity

QUM

At the end of 2018, three Q2 monitor wells had been hydraulically tested in the Project area. The range in hydraulic conductivity of all Q2 tests is 2.65×10^{-5} to 5.25×10^{-4} cm/sec, and the geometric mean of those tests is 2.8×10^{-4} cm/sec.

Bedrock

Data from packer and aquifer testing to date has yielded a range of hydraulic conductivity from 4.6×10^{-10} to 3.0×10^{-4} cm/sec. Studies to date show that hydraulic conductivities are generally at the higher end of the measured range generally above 300 ft (91.4 m) bgs, while hydraulic conductivities are generally very low below 300 ft (91.4 m) bgs.

The hydraulic conductivity data from corehole packer test and monitor well aquifer tests were plotted and reviewed. The data set was filtered by removing results of tests conducted above the depth of 100 feet as well as tests in which the lower limit of resolution of the equipment was exceeded. Figure 6-12 is a plot showing measured hydraulic conductivity versus bedrock depth. Testing shows that the hydraulic conductivity of bedrock decreases with depth. The red line on the plot is the geometric mean of hydraulic conductivity values within specific depth intervals in bedrock. As shown, the hydraulic conductivity values range over many orders of magnitude and reflect the nature of the bedrock hydraulics where groundwater flow tends to occur in discrete intervals that are a small portion of the rock mass and are vertically separated. The black line on this plot approximates the likely maximum hydraulic conductivity values with depth and shows a decrease in hydraulic conductivity with depth.

Hydraulic conductivity results from the 2019 aquifer testing field program will be added to the hydraulic conductivity database and used to update the plot on Figure 6-12. This information will improve the understanding of the groundwater flow system and the hydraulic properties of HGU’s in the Project area vicinity.

Based on the distribution of hydraulic conductivity with respect to underground mining areas under consideration coupled with the very low hydraulic conductivity values measured, very little mine inflow is expected. Figure 6-13 shows the depth and percentage of mine workings with respect to the measured hydraulic conductivity distribution. As shown on Figure 6-13, 74% of the mine workings are expected to produce virtually no flow due the low hydraulic conductivities at depths >1,600 ft (487.7 m) and the high percentage of mining occurring below 1,600 ft (487.7 m). Measurable groundwater inflows are expected in about 21% of the upper mine workings. The lack of groundwater flow into the mine is expected to minimize hydrological effects associated with mine dewatering.

Site-Specific Groundwater Flow Direction

Groundwater flow directions for the QUM and shallow bedrock HGUs were evaluated based on the water level data collected for the June 2019 measurement event. Available data is primarily for the underground mine area. The Birch Lake outlet maintained a lake water elevation of approximately 1,419.5 ft (432.7 m) amsl at the time the water level measurements were obtained.

Potentiometric surface maps of the QUM HGU (Q2 monitor wells), the upper portion of the shallow bedrock HGU (B1 monitor wells), and the deeper portion of the shallow bedrock HGU (B2 monitor wells), are presented as Figure 6-14, Figure 6-15, and Figure 6-16, respectively.

To construct each potentiometric surface, Birch Lake and the South Kawishiwi River were assumed to represent regional groundwater hydrologic boundary with a prescribed hydraulic head elevation of 1,419.5 ft (432.7 m) amsl. The groundwater level contour lines fit the measured water levels and the presence of this hydrologic boundary. As expected, the water level data shows flow directions in all three depth intervals which are generally oriented towards Birch Lake and the South Kawishiwi River. Additionally, the potentiometric surfaces mimic each other in terms of contour geometry and elevation as would be expected in this system.

While the groundwater contours show a shallow hydraulic gradient towards Birch Lake, the very low hydraulic conductivity of the bedrock severely limits the potential for actual flow of groundwater from the deeper bedrock HGU into Birch Lake. The likelihood of flow paths going toward Birch Lake decreases with depth in the bedrock due to: (1) increasing vertical distance required for a relatively short horizontal distance from the BMZ to Birch Lake, and (2) decreasing vertical conductivity with depth. Groundwater from the deep bedrock HGU (which would be exposed during mining) presents a very low potential for interaction with Birch Lake due to the extremely low hydraulic conductivity measured in this HGU and because flow would have to move vertically upward over 3,500 feet within a small horizontal distance, which is highly unlikely. Even though the shallow hydraulic gradient is oriented towards Birch Lake, virtually all of the subsurface flow would be from the more permeable QUM HGU. Shallow bedrock and deep bedrock contributions to Birch Lake are likely to be negligible.

The very low hydraulic conductivity of the deep bedrock has been demonstrated by the very slow recovery of several of the newly constructed B4 wells. Of the six B4 wells constructed, as of fall 2019, five have not yet recovered over a range of 25 to 79 weeks to static water elevations and are exhibiting very slow recovery rates. Monitor well MN-503B4 located near the BMZ outcrop has recovered to static water elevation conditions and currently is the only viable water level measurement point. Once the other B4 monitor wells have sufficiently recovered, data from the B4 monitor well network will be used to construct a potentiometric surface for the deep bedrock HGU.

Groundwater – Surface Water Interactions

The QUM HGU is in direct contact with surface water features and can serve locally as a either a recharge source or a discharge sink depending on the bedrock surface geometry. The bedrock HGUs generally are not in direct contact with surface water features and primarily function as a layer which retards infiltration of precipitation and directs precipitation to surface water features through the QUM. Hydraulic contact and flow between the bedrock HGUs and surface water features is negligible due to the minimal hydraulic conductivity of the bedrock and the shallow hydraulic gradients in the area.

6.1.2.4 Groundwater Quality

This section provides an overview of regional groundwater quality then summarizes the site-specific groundwater data collected by TMM.

Regional Groundwater Quality

Groundwater quality in Northern Minnesota varies locally with geology and with depth, but can be generalized broadly as hard water, with elevated concentrations of iron and / or manganese (Cotter et al, 1965; Maclay, 1966). Siegel and Ericson (1980) reported groundwater quality from within the Project area and observed significant differences related directly to the geology of the aquifer. For example, the reported mean and median concentrations of major ions, specific conductivity, and hardness in water from till hydrostratigraphic units was twice that found in water from sand and gravel aquifers. The source of some of this variation may be related to the surface area to volume ratios between the till and sand / gravel aquifers and retention / contact times due to differences in hydraulic conductivity.

The observed pH of water from sand and gravel aquifers ranged from 5.8 to 7.1 while the pH of water from Rainy Lobe till ranged from 6.2 to 8.0. This difference likely reflects rapid recharge to the sand and gravel aquifers from precipitation, and a shorter time available for equilibration and chemical reactions with aquifer material (Siegel and Ericson, 1980).

Samples from sand and gravel aquifers, and also from peat, are mixed calcium-magnesium bicarbonate type groundwater, which is typical of groundwater in contact with calcic igneous minerals. Water sampled from wells in till are calcium-magnesium-bicarbonate or calcium-magnesium-sulfate type, with the latter being collected in the vicinity of the Project area (Siegel and Ericson, 1980). Concentrations of trace metals such as copper, cobalt, and nickel are generally low (<30 µg/L) but can exceed 100 µg/L in surficial material directly over the mineralized contact zone between the Duluth Complex and older rocks. Siegel and Ericson (1980) attribute these concentrations to the oxidation of sulfide ores at the contact zone. Less variation is observed in chromium, cadmium, and lead. Iron concentrations vary strongly and may reflect local redox conditions.

Groundwater quality in the deeper wells is difficult to characterize from historical data but can be characterized as sodium-chloride to sodium-bicarbonate type. The occurrence of localized brackish water has been reported by the SNF. Siegel and Ericson (1980) sampled six wells in the Duluth Complex, and observed high level of variability. For example, chloride concentrations ranged three orders of magnitude, from 1.3 to 1500 mg/L. Some data suggests concentrations may increase with depth, but it is likely that groundwater quality is a function of local hydrogeochemical conditions because water in the Duluth Complex occurs in isolated fractures and joints. The pH of water at depth was generally neutral to basic ranging from 7.0 to 8.5.

MPCA (GWMAP, 1999) reports that groundwater quality is generally good in the region, and generally controlled by geology. Precambrian aquifers in the region have groundwater quality comparable to similar aquifers statewide. Concentrations of major cations and anions are generally lower in Quaternary hydrostratigraphic units relative to deeper units statewide, though concentrations of trace metals can be higher. Trace inorganic parameters that may be of concern locally include beryllium, boron, manganese, arsenic, and selenium. In general, the Quaternary aquifers tend to be calcium-magnesium-bicarbonate type waters, while localized deeper water can be sodium chloride type.

Site-Specific Groundwater Quality

The following description and characterization of the site-specific water quality is based on field and laboratory results from the sampling events during the second, third and fourth quarters of 2018. Fourteen wells were sampled during the second quarter, 16 wells were sampled during the third quarter, and 25 wells were sampled during the fourth quarter. Twelve wells were sampled during all three quarters. Average concentrations for monitored parameters at these locations are presented in Table 6-26 through Table 6-28. The monitor well network is shown on Figure 6-11.

Samples have also been collected in Q1 and Q2 of 2019 but the data is not currently available and has not been presented here. As monitor wells are adequately developed and have recovered to approximate pre-drilling conditions, they will be added to the water quality sampling network to provide spatial and temporal information to further characterize the groundwater quality of the Project area.

Table 6-26 Average Groundwater General Parameter Concentrations from Wells Measured in 2018

Parameter	Units	EISV-509B1	MN-512B1	MN-522B1	MN-543B1	MN-544B1	MN-545B1	EISV-509B2	MN-522B2	MN-544B2	EISV-511Q2	EISV-511Q2A	MN-520Q2	MN-503B4 [1]
Alkalinity as $CaCO_3$	mg/L	96.9	114.0	173.0	7.3	94.3	150.0	109.0	163.0	72.8	76.2	42.0	70.9	72.3
Alkalinity, Bicarbonate as $CaCO_3$	mg/L	96.9	114.0	166.0	7.3	69.6	125.0	109.0	163.0	18.5	76.2	42.0	70.9	61.3
Alkalinity, Carbonate as $CaCO_3$	mg/L	ND	ND	5.0	ND	23.4	22.3	ND	ND	54.0	ND	ND	ND	11
Bromide, Total as Br	mg/L	0.040	0.054	0.500	1.100	0.042	0.061	0.020	0.082	0.130	ND	ND	0.190	0.330
Chloride	mg/L	2.2	4.6	64.4	1180.0	0.9	4.1	1.6	5.8	9.4	0.9	0.3	3.3	42.9
Dissolved Organic Carbon	mg/L	3.6	7.7	3.6	2.9	3.3	7.8	7.6	6.8	6.2	4.3	4.6	34.3	13.5
Dissolved Oxygen	mg/L	2.99	2.05	4.70	3.63	2.98	6.08	4.76	1.89	2.49	2.21	5.92	1.89	3.69
Fluoride	mg/L	0.21	0.14	0.14	0.08	0.15	0.23	0.14	0.24	0.44	0.07	0.03	0.08	0.69
Hardness	mg/L	86.200	87.700	153.000	1720.000	90.500	46.000	24.000	31.700	11.200	71.500	38.700	69.200	72.700
Methane, % of Dissolved Gases	µg/L	0.7	16.5	168.0	43.5	2.9	14.4	49.3	1309.7	59.2	1.7	3.5	60.5	53.3
Nitrogen, Ammonia	mg/L	0.068	ND	0.071	ND	ND	ND	0.030	ND	ND	ND	ND	ND	0.185
Nitrogen, NO_3 + NO_2	mg/L	0.062	ND	0.057	0.019	ND	0.110	0.007	ND	ND	0.180	0.340	ND	0.015
pH	s.u.	6.47	7.27	7.67	7.39	9.36	9.30	7.11	7.55	9.62	6.13	6.42	5.63	8.49
Phosphate, Total as PO_4	mg/L	0.036	0.052	0.170	0.017	0.095	0.430	0.087	0.130	0.340	0.034	0.006	0.012	0.170
Phosphorus	mg/L	0.038	0.056	0.180	0.140	0.310	0.930	0.089	0.180	0.330	0.053	0.009	0.046	0.290
Redox Potential	mV	171.4	-38.7	135.1	83.3	95.3	98.9	-54.8	113.8	80.5	137.3	219.4	153.0	209.4
Specific Conductance	µS/cm @25 C	220.9	228.7	376.8	3651.0	208.1	312.3	198.8	301.3	183.5	144.3	76.1	173.6	281.9
Sulfate	mg/L	27.4	15.4	3.5	16.3	8.3	4.7	6.0	11.6	11.7	4.2	4.1	3.3	10.8
Sulfide	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Temperature	deg C	8.32	6.70	8.40	7.22	7.48	7.41	7.68	7.30	6.50	10.50	9.14	9.55	8.06
Total Dissolved Solids	mg/L	181.0	157.0	276.0	3350.0	142.0	220.0	181.0	238.0	150.0	91.3	77.0	158.0	312.0
Total Suspended Solids	mg/L	0.4	2.2	13.6	143.0	51.5	41.3	9.4	42.8	38.0	11.8	2.0	6.8	85.5
Turbidity	NTU	19.0	5.6	30.5	82.7	32.5	54.7	23.2	40.6	25.2	2.9	4.2	8.0	307.5

Notes:
Average concentrations of groundwater from three sampling events in 2018.
Non-detects were set equal to 0 for average calculations presented in this table. This methodology will be reviewed and modified, as needed, during environmental review. ND is reported when all results for a particular parameter and location were non-detectable.
Decimal formatting is generally in alignment with laboratory analytical reporting.
[1] MN-503B4 was not sampled in second quarter 2018; average concentrations for MN-503B4 taken from third and fourth quarters of 2018.
Abbreviations:
µS/cm@25 C = microSiemens/centimeter at 25 degrees Celsius
deg C = degrees in Celsius
mg/L = milligrams per liter
mV = millivolts
ND = non-detectable
NTU = nephelometric turbidity units
s.u. = standard units

Table 6-27 Average Groundwater Total Metals Concentrations from Wells Measured in 2018

Parameter	Units	EISV-509B1	MN-512B1	MN-522B1	MN-543B1	MN-544B1	MN-545B1	EISV-509B2	MN-522B2	MN-544B2	EISV-511Q2	EISV-511Q2A	MN-520Q2	MN-503B4 [1]
Aluminum	µg/L	20.4	149.0	755.0	6240.0	3160.0	2050.0	509.0	1940.0	898.0	390.0	63.0	689.0	14305.0
Antimony	µg/L	0.73	0.10	ND	0.40	0.34	0.31	0.07	0.69	0.61	ND	ND	ND	0.45
Arsenic	µg/L	ND	0.64	0.45	ND	0.87	1.90	ND	0.29	3.50	ND	ND	0.90	2.25
Barium	µg/L	34.2	18.1	17.3	491.0	17.0	12.3	10.9	14.9	8.5	25.1	5.3	25.6	78.6
Beryllium	µg/L	ND	ND	ND	0.04	0.05	ND	ND	0.290	ND	ND	ND	0.065	0.35
Boron	µg/L	24.0	1.9	26.8	16.9	4.2	5.1	61.2	73.1	33.2	1.8	ND	3.1	70.1
Cadmium	µg/L	ND	0.110	ND	0.053	ND	ND	ND	0.057	0.033	ND	ND	0.026	0.110
Calcium	µg/L	23200	23800	34900	675000	28400	13700	6300	7830	3420	14600	8860	9870	10685
Chromium	µg/L	0.3	0.4	3.2	22.1	24.1	4.7	1.7	4.9	3.0	0.7	0.2	2.9	29.8
Cobalt	µg/L	0.1	0.4	0.5	2.8	1.4	0.4	1.3	0.8	0.6	0.4	0.1	53.4	12.0
Copper	µg/L	2.7	23.0	4.1	9.4	5.8	8.8	13.3	6.0	29.1	4.8	5.8	22.8	492.5
Iron	µg/L	18	387	463	2010	1860	445	506	608	574	362	76	6990	16550
Lead	µg/L	ND	0.250	ND	0.190	1.300	0.074	0.220	1.000	0.230	0.063	ND	0.037	3.400
Lithium	µg/L	0.70	3.10	ND	0.90	0.53	ND	0.47	0.57	1.70	0.97	ND	ND	6.10
Magnesium	µg/L	6920	6870	15900	7600	4730	2910	2010	2970	638	8510	4030	10800	11160
Manganese	µg/L	180	170	65	590	38	17	88	46	21	103	10	1910	291
Mercury	ng/L	0.74	6.42	0.92	1.05	2.66	1.21	1.96	2.66	3.82	1.42	2.51	21.70	13.38
Molybdenum	µg/L	1.20	0.97	3.70	3.40	4.00	1.70	3.90	6.30	3.30	1.80	0.00	0.37	13.10
Nickel	µg/L	1.2	2.4	5.2	23.9	19.7	4.6	2.9	4.7	4.4	1.9	1.8	36.6	169.5
Palladium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Platinum	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	µg/L	2200	5410	1300	4370	2320	2970	690	960	1710	1010	1050	654	2005
Selenium	µg/L	0.20	0.12	0.84	3.70	ND	0.42	ND	ND	0.44	ND	ND	0.78	1.50
Silicon	µg/L	8667	8497	11300	11487	13567	11960	8520	14300	19033	14433	10933	14523	41300
Silver	µg/L	ND	0.10	0.33	1.50	0.33	0.96	0.25	0.06	0.43	0.00	0.00	0.24	12.10
Sodium	µg/L	16300	21800	44400	340000	19000	45000	44200	69300	38200	4960	2880	5370	53400
Strontium	µg/L	43.9	44.4	90.4	767.0	28.7	23.5	15.9	28.9	12.3	43.0	33.0	89.0	58.3
Thallium	µg/L	ND	0.017	ND	0.007	0.008	ND	ND	0.027	0.008	ND	0.007	0.009	0.063
Titanium	µg/L	2.0	4.6	8.5	82.6	69.6	14.6	9.3	13.2	15.5	17.0	3.5	7.2	324.5
Uranium	µg/L	0.20	0.34	0.51	0.05	0.52	0.83	0.14	0.71	0.13	0.02	0.01	0.15	0.97
Zinc	µg/L	42.9	7.9	5.9	4.4	14.6	2.9	3.7	9.2	5.4	10.1	4.1	4.5	68.3

Notes:
Average concentrations of groundwater from three sampling events in 2018.
Non-detects were set equal to 0 for average calculations presented in this table. This methodology will be reviewed and modified, as needed, during environmental review. ND is reported when all results for a particular parameter and location were non-detectable.
Decimal formatting is generally in alignment with laboratory analytical reporting.
[1] MN-503B4 was not sampled in second quarter 2018; average concentrations for MN-503B4 taken from third and fourth quarters of 2018.
Abbreviations:
µg/L = micrograms per liter
ND = non-detectable
ng/L = nanograms per liter

Table 6-28 Average Groundwater Dissolved Metals Concentrations from Wells Measured in 2018

Parameter	Units	EISV-509B1	MN-512B1	MN-522B1	MN-543B1	MN-544B1	MN-545B1	EISV-509B2	MN-522B2	MN-544B2	EISV-511Q2	EISV-511Q2A	MN-520Q2	MN-503B4 [1]
Aluminum	µg/L	ND	26	11	13	22	60	66	192	289	7	7	623	2830
Arsenic	µg/L	ND	0.49	0.15	ND	0.09	0.77	ND	0.22	2.60	ND	ND	0.87	2.10
Boron	µg/L	26.3	4.3	29.6	27.2	4.8	6.1	64.2	75.2	34.4	5.3	3.9	5.6	69.9
Cadmium	µg/L	ND	ND	ND	0.037	ND	ND	ND	ND	0.000	ND	ND	0.029	ND
Chromium	µg/L	0.1	0.4	0.3	0.6	4.0	1.8	0.5	1.2	1.5	0.1	0.1	2.7	6.5
Cobalt	µg/L	0.3	0.6	0.7	0.8	0.6	0.2	0.3	0.6	0.9	0.2	0.1	54.1	2.9
Copper	µg/L	2.1	1.6	1.1	1.4	0.6	2.4	1.7	2.3	11.0	2.9	5.2	15.6	101.0
Iron	µg/L	3	267	53	17	23	39	99	58	94	12	4	6780	3180
Manganese	µg/L	180	150	66	556	12	8	61	36	11	19	1	2010	82
Molybdenum	µg/L	1.20	0.70	3.10	1.80	1.00	0.83	3.70	6.20	2.70	2.10	0.00	0.27	13.85
Nickel	µg/L	0.9	1.8	1.4	3.8	1.3	1.5	1.4	1.5	1.8	0.6	1.4	35.8	54.6
Selenium	µg/L	0.14	ND	0.97	3.10	ND	ND	ND	0.16	0.63	ND	ND	1.00	1.05
Silver	µg/L	ND	ND	ND	ND	ND	ND	0.02	ND	0.10	ND	ND	0.15	1.50
Zinc	µg/L	43.5	0.7	2.0	2.6	1.6	0.4	1.3	3.0	2.8	2.1	3.8	3.2	15.5

Notes:
Average concentrations of groundwater from three sampling events in 2018.
Non-detects were set equal to 0 for average calculations presented in this table. This methodology will be reviewed and modified, as needed, during environmental review. ND is reported when all results for a particular parameter and location were non-detectable.
Decimal formatting is generally in alignment with laboratory analytical reporting.
[1] MN-503B4 was not sampled in second quarter 2018; average concentrations for MN-503B4 taken from third and fourth quarters of 2018.
Abbreviations:
µg/L = micrograms per liter
ND = non-detectable

QUM HGU (Q2) Monitor Wells

Three Q2 wells were monitored during each of the three quarters sampled in 2018, including EISV-511Q2, EISV-511Q2A, and MN-520Q2.

Groundwater in the QUM can be characterized as either calcium-bicarbonate or magnesium-bicarbonate type waters. The pH of water in the Q2 wells was the lowest of the three HGUs, averaging 5.6 to 6.4, and likely reflecting meteoric influence. Groundwater in the QUM had higher average temperatures than deeper HGUs, and generally lower turbidity and TDS. Groundwater in the QUM ranged from soft to moderately hard and was buffered with average alkalinity ranging from approximately 40 to 75 mg/L. Ion concentrations were generally more dilute than wells in other HGUs, with concentrations of sodium that were nearly an order of magnitude less than what was observed in shallow bedrock HGU wells. Similarly, sulfate concentrations at Q2 wells were lowest of any HGU with average concentrations of approximately 4 mg/L. Nickel and copper concentrations are low in two of three wells in the QUM HGU. Nutrient concentrations are low to non-detect in Q2 wells.

Shallow Bedrock HGU (B1) Monitor Wells

Six B1 wells were monitored during each of the three quarters sampled in 2018, including EISV-509B1, MN-512B1, MN-522B1, MN-543B1, MN-544B1, and MN-545B1.

The B1 wells exhibit more heterogeneous water quality and include calcium-bicarbonate type, sodium-bicarbonate type, and magnesium-bicarbonate type waters, with some wells reflecting water quality similar to the QUM HGU while others showing signatures more similar to B2 wells. For example, the average pH observed in B1 wells ranged from 6.5 to 9. Average chloride concentrations ranged three orders of magnitude from 0.9 to 1180 mg/L. Similarly, large variation and ranges were observed in average concentrations for TDS, (142 to 3350 mg/L), for turbidity (5.6 to 82.7 mg/L), for hardness (46 to 1720 mg/L) and for alkalinity (7.3 to 173 mg/L). The range of constituents may be related to continued well and adjacent bedrock HGU recovery and will be further evaluated as the hydrologic system equilibrates and additional data is obtained and will be monitored as the wells are further purged or developed. Average metals concentrations are generally low in B1 wells with occasional exceptions (i.e., copper at MN-512B1, nickel at MN543B1 and MN-544B1, and zinc at EISV-509B1). Comparison between B1 wells and surface water shows that the surface water concentrations are more dilute than the groundwater.

Shallow Bedrock HGU (B2) Monitor Wells

Three B2 wells were monitored during each of the three quarters sampled in 2018, including EISV-509B2, MN-522B2, and MN-544B2.

The B2 wells are characterized as sodium-bicarbonate type waters, with higher concentrations of sodium than the Q2 wells and some of the B1 wells. The pH of the B2 wells is higher than the Q2 wells, and generally more buffered. Relative to the Q2 wells, the B2 wells have higher TDS, higher TSS, and higher turbidity. Average water temperature is lower in these deeper wells, though average dissolved oxygen concentrations were comparable to Q2 and B1 wells. Average sulfate concentrations were higher in B2 wells than in Q2 wells. Nickel and copper concentrations were generally low in the B2 wells, with the exception of elevated average concentration at MN-544B2. Comparison to surface water shows that surface water is more dilute than B2 groundwater and while surface water is calcium-bicarbonate type, the dominant cation in B2 groundwater is sodium.

Deep Bedrock HGU (B4) Monitor Wells

A single B4 well, MN-503B4, was available for sampling during the third and fourth quarters of 2018. Average concentrations, based on the two available sampling events are presented in Table 6-26 through Table 6-28. Water quality between these two events was characteristically different between the two samples and subject to further evaluation as additional sample data is obtained. The summary in the following paragraph compares the fourth quarter results from MN-503B4 to other HGUs.

Water quality is characterized as sodium-bicarbonate type, similar to the B2 wells. The pH in the B4 well was well buffered and slightly basic, with moderate hardness. The turbidity and TSS were elevated relative to the Q2 wells. Sulfate concentration was relatively low at approximately 10 mg/L. Metals concentrations (e.g., aluminum and iron) were two to three orders of magnitude higher than what was measured in other wells. The cations / anions in well MN-503B4 were significantly more concentrated than surface water as would be expected in a monitor well screened within the mineralized BMZ, however the average TDS concentration was two orders of magnitude lower than the concentration defined as a brine.

6.1.2.5 Groundwater Use

The Minnesota Department of Health (MDH) establishes well head protection zones which serve to limit activities which could impact public water supplies. The Project would be located outside of any establish well head protection zone with the closest wellhead protection area located in Babbitt about 10 miles (16 km) from the plant site as shown on Figure 6-17. Twenty-five private and public water wells are located within 1 mile (1.6 km) of the underground mine area, plant site, and tailings management site as identified in the Minnesota Well Index (MWI). Wells registered with in the MWI are shown on Figure 6-18.

6.1.3 Wetlands

This section describes the available data sources, then characterizes the wetlands in the Project area using two different classification systems:

- The simplified plant community classification system – The Minnesota update of the National Wetlands Inventory (NWI) uses a classification system that is based on the Eggers and Reed (2015) system. In the NWI data, the Eggers and Reed (2015) classification system was simplified from the 15 original classes to nine vegetated classes and one non-vegetated aquatic class (Macleod et al., 2016). This simplification was done because of the difficulty of assessing distinctions between these plant community classes at a remote sensing scale. This classification system was used to describe the wetlands in the Project area because the Eggers and Reed system is commonly used to quantify potential wetland impacts and set wetland replacement goals: and

- The Circular 39 classification system - The Circular 39 system was developed by the U.S. Fish and Wildlife Services (USFWS) in 1956 and broadly divides the wetlands in Minnesota into eight types. This classification system was used to describe wetlands in the Project area because it is required for an EAW by EQB guidance.

6.1.3.1 Data Sources

The Minnesota update of the NWI was used to establish a baseline of wetlands in the Project area. This is a public geographic information system (GIS) database based on the framework of the NWI and was created for use for wetland regulation and management, land use and conservation planning, environmental impact assessment, and natural resource inventories (Macleod et al., 2016). The update uses the same wetland definition as was used for the original NWI (adapted from Cowardin et al., [1979]):

- "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season each year."

6.1.3.2 Simplified Plant Community Classification System

Baseline acreages of wetlands in the Project area, calculated using the simplified plant community classification system, are listed in Table 6-29, and shown on Figure 6-19 and Figure 6-20. In the NWI data, the Eggers and Reed (2015) classification system was simplified from the 15 original classes to nine vegetated classes and one non-vegetated aquatic class (Macleod et al., 2016). This simplification was done because of the difficulty to assess distinctions between these plant community classes at a remote sensing scale. This Eggers and Reed classification system was used to estimate the wetlands in the Project area because it is the Eggers and Reed system is commonly used regarding quantifying potential wetland impact and setting wetland replacement goals.

Table 6-29 Minnesota National Wetland Inventory Simplified Plant Community Classification Baseline for the Project Area

Wetland Type	Baseline Acres[1]
Coniferous Bog	818.7
Hardwood Swamp	110.5
Non-Vegetated Aquatic Community	60.9
Open Bog	360.3
Seasonally Flooded/Saturated Emergent Wetland	26.7
Shallow Marsh	169.5
Shallow Open Water Community	5.5
Shrub-Carr Wetland	187.2
Total	1739.3

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

The most common wetlands within the Project area by this classification system are Coniferous Bog, Open Bog, and Shrub Wetland. These wetland types are also the most common wetlands in the Rainy River - Headwaters watershed. The Minnesota update to the NWI calculated summary statistics of wetlands for the whole Rainy River – Headwaters watershed and showed that the main wetland types by the simplified plant community classification system are Non-Vegetated Aquatic Community (37.9%), Coniferous Bog (32.8%), and Shrub Wetland (8.5%) and Open Bog (8.1%) (Kloiber et al., 2019).

Brief descriptions from Eggers and Reed (2015) of the wetland types present in the Project area are included below.

Coniferous Bog

Mature trees are present and form closed stands with more than 50% canopy cover. Coniferous trees, specifically tamarack and black spruce, are dominant. Soils are typically acidic and water saturated with continuous sphagnum moss mats (Eggers and Reed, 2015).

Hardwood Swamp

Similar to the coniferous bog, mature trees are present and form more than 50% canopy cover. Hardwood trees are dominant tree types (e.g., Black ash, green ash, American elm, etc.) and the soils are typically alluvial, peaty / mucky, or poorly drained mineral soils (Eggers and Reed, 2015).

Non-Vegetated Aquatic Community

This class includes all non-vegetated aquatic communities including unconsolidated bottoms, rock bottoms, rocky shores, unconsolidated shores, and streambeds (Macleod et al., 2016).

Open Bog

In the open bog-type communities mature trees are absent or present in open, sparse stands. Other woody plants are shrubs or saplings and pole-size trees. Open bog communities are dominated by woody shrubs and sphagnum moss may or may not be present. Soils are wet or poorly-drained soils or in groundwater seepage areas (Eggers and Reed, 2015).

Seasonally Flooded / Saturated Emergent Wetland

Seasonally flooded / saturated emergent wetland are open communities with <50% vegetative cover during the early growing season or shallow open water with submergent, floating, and / or floating-leaved aquatic vegetation. When vegetation exists, it is dominated by herbaceous plants. Standing water may be present but generally these are dry and dominated by annuals such as smartweeds and wild millet (Eggers and Reed, 2015).

Shallow Marsh

Closed community dominated by herbaceous plants growing on saturated soils to areas covered by standing water up to 6 inches in depth throughout most of the growing season. Dominant vegetation includes sedges, particularly cattails, bulrushes, water plantain, Phragmites, arrowheads, slough sedge, and / or lake sedges. Soils are usually neutral to alkaline, poorly-drained and range from mineral soils to mucks (Eggers and Reed, 2015).

Shallow Open Water Community

Shallow open water communities are areas of shallow, open water (<2 m in depth) dominated by submergent, floating and / or floating-leaved aquatic vegetation (Eggers and Reed, 2015).

Shrub-Carr Wetland

Shrub-carr wetlands are communities dominated by tall, woody deciduous shrubs usually >3 ft high. Mature trees are generally absent or present in open, sparse stands. Soils are wet, lowland, or poorly-drained soils, or in groundwater seepage areas. Willows, red-osier dogwood, silky dogwood, meadowsweet and / or steeplebush are dominant on neutral to alkaline poorly drained muck / mineral soils (Eggers and Reed, 2015).

6.1.3.3 Circular 39 Classification System

Baseline acreages of wetlands in the Project area, calculated using the Circular 39 classification system, are listed in Table 6-30, and shown on Figure 6-21 and Figure 6-22. Acreages in the Project area were estimated using this system as its simplicity is an asset for remote sensing and desktop mapping. Similar to the simplified plant classification system, the Circular 39 wetland classifications show that the most common wetlands within the Project area are also the most common in the Rainy River - Headwaters watershed.

Table 6-30 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Baseline for the Project Area

Wetland Type	Baseline Acres[1]
Type 1 Seasonally flooded basins or flats	3.9
Type 2 Wet Meadows	22.8
Type 3 Shallow Marsh	169.5
Type 4 Deep Marsh	8.3
Type 5 Shallow Open Water	38.5
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	187.2
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	110.5
Type 8 Bogs; Coniferous Bogs, Open Bogs	1179.1
90 Rivers and streams	19.6
Total	1739.4

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

The most common wetlands within the Project area by this classification system are Type 8 Bogs, Type 6 Shrub Swamp, and Type 3 Shallow Marsh. The Minnesota update to the NWI calculated summary statistics of wetlands for the whole Rainy River – Headwaters watershed and showed that the main wetland types by the Circular 39 system are Type 8 Bogs (40.9%), Type 5 Shallow Open Water (38.6%), Type 6 Shrub Swamp (8.6%), and Type 3 Shallow Marsh (5.0%) (Kloiber et al., 2019).

The following are narrative descriptions of the Circular 39 wetland types.

Type 1: Seasonally Flooded Basin or Floodplains

This wetland occurs in both upland depressions and in overflow bottomlands. Soils are water covered or water logged but typically well-drained during much of the growing season. Vegetation varies according to the season and amount of flooding but can include smartweeds, wild millet, fall panicum, chufa, various amaranths, and other plants (i.e., marsh elder, ragweed, and cockleburs) (Shaw and Fredine, 1971).

Type 2: Wet Meadows

In wet meadows standing water is usually absent during most of the growing season but is saturated within at least a few inches of the surface. Vegetation includes grasses, sedges, rushes, and various broad-leaved plants. Other wetland plant community types include low prairies, sedge meadows, and calcareous fens (Shaw and Fredine, 1971).

Type 3: Shallow Marsh

Shallow marsh wetland types typically have waterlogged soils early in the spring and are often covered by 6 inches or more of water. Vegetation includes grasses, bulrushes, spike rushes, cattails, arrowheads, pickerelweed, and smartweeds. These marshes may nearly fill shallow lake basins or sloughs or may border deep marshes on the landward side (Shaw and Fredine, 1971).

Type 4: Deep Marsh

Soils in deep marsh wetland types are usually covered with water from 6 inches to 3 ft or more of water during the growing season. These deep marshes may completely fill shallow lake basins, potholes, limestone sinks and sloughs, or they may border open water in such depressions. Vegetation includes cattails, reeds, bulrushes, spikerushes, and wild rice and in open areas pondweeds, naiads, coontail, watermilfoils, waterweeds, duckweed, water lilies, or spatterdocks may occur (Shaw and Fredine, 1971).

Type 5: Shallow Open Water

Shallow open water wetlands are completely inundated with water up to 10 ft deep and fringed with a border of emergent vegetation which is similar to open areas of Type 4. Vegetation mainly occurs in areas <6 ft deep and includes pondweeds, naiads, wild celery, coontail, watermilfoils, muskgrass, waterlilies, and spatterdocks (Shaw and Fredine, 1971).

Type 6: Shrub Swamp; Shrub Carr, Alder Thicket

In shrub swamps the soil is usually waterlogged during the growing season and can be covered with as much as 6 inches of water. Shrub swamps occur mostly along slow moving streams and typical vegetation includes alders, willows, buttonbush, and dogwoods (Shaw and Fredine, 1971).

Type 7: Wooded Swamps; Hardwood Swamp, Coniferous Swamp

Wood swamp wetlands are waterlogged to at least to within a few inches of the surface during the growing season and are often covered with a foot of water or more. Wood swamps can occur along slow-moving stream, oxbow lakes, flood plains, or in very shallow lake basins. Tree vegetative species include tamarack, white cedar, black spruce, balsam fir, red maple, and black ash. Commonly the soil has a thick covering of moss (Shaw and Fredine, 1971).

Type 8: Bogs; Coniferous Bogs, Open Bogs

Bog wetland soils are water logged and the soils are covered by mosses. These wetland types occur in shallow lake basins or along slow-moving stream. Vegetation is variable and can range from wood to herbaceous. Black spruce and tamarack may occur in northern bogs and leatherleaf, Labrador-tea, cranberries, Carex, and cottongrass are often present (Shaw and Fredine, 1971).

6.2 Project Impacts

Potential impacts to water resources would be avoided, minimized, and mitigated as described in the section *Environmental Protection Measures*. The following sections assess potential impacts from the Project to the baseline surface water, groundwater, and wetland resources that are anticipated based on the current Project design, including the EPMs. Other impacts could possibly result from the

Project, but further work is needed prior to determine whether the impact could occur and if so, how significant it would be. Future work to assess the nature and extent of potential impacts that have been identified, and to identify whether other potential impacts would occur is discussed in Section 6.3.

6.2.1 Surface Water

6.2.1.1 Project Water Management

As described in the section *Water Management Plan*, the Project would not require treatment and discharge of process water and would instead reuse all process water during processing. Closure and reclamation of the plant site and tailings dewatering plant would include use of surface water management features to control erosion, and stormwater quality, quantity, and rates.

Domestic wastewater would be collected and disposed of off-site by a licensed, third-party contractor and would not be included in the Project water management plans.

6.2.1.2 Birch Lake Water Withdrawal – Effects to Birch Lake and Downstream Hydrologic System

Water would be pumped from Birch Lake to support operations when contact and process reuse water sources are insufficient. Potential impacts to Birch Lake include changes to lake levels.

The potential impacts due to appropriating water from Birch Lake were calculated based on the watershed area, lake volume, reported gaged flows downstream, and projected use volume. Preliminary calculations show that appropriating water required to meet process demand (800 gpm) would be equivalent to <2 inches (5 cm) of water level decrease to Birch Lake. This calculation overestimates the need for process demand, assumes a continuous appropriation (24 hours per day, 7 days per week, 365 days per year), and does not account for inflows or dam operational water management). Birch Lake is controlled by a dam on TH 1 operated by Minnesota Power to control water levels for the Winton Hydroelectric Station. Dam operation results in a winter drawdown of about 4 ft. These data show that the amount of water withdrawn from the reservoir for the Project would be <5% of the annual 4 ft variation due to the water management for the Winton Hydroelectric Station (Section 6.1.1).

Based on this simple calculation, it appears that Birch Lake would be sufficient to supply the required make up water for the Project and the impact of water appropriations would be insignificant compared with the managed water level fluctuation of the reservoir.

6.2.1.3 Plant Site Contact Water and Industrial Stormwater Management - Effects on Surface Water Hydrology

Due to the contact water management system and industrial stormwater management system, precipitation falling within the contact water area of the plant site and the majority of precipitation falling within the industrial stormwater areas of the plant site would no longer contribute to the surface water hydrologic system (except during infrequent industrial stormwater discharge events), essentially removing watershed area from affected streams. During Project closure and reclamation natural drainage patterns would be re-established to the extent possible, minimizing the potential for permanent impacts. Potential effects of this impact may include reduced stream flows under a variety of low flow conditions, indirect effect locally on surface water contribution to wetlands, and reduction in flow to Birch Lake. Additionally, the reduction in precipitation reaching the surface water hydrologic system in the plant site may also reduce groundwater recharge as discussed in Section 6.2.2, *Changes in Groundwater Recharge Associated with the Plant Site Contact Water and Industrial Stormwater Management*. Containment and rerouting of stormwater are expected to have a negligible effect on surface water quality. No future scope is proposed to address this issue.

6.2.1.4 Tailings Management Site Contact Water and Industrial Stormwater Management – Effects on Surface Water Hydrology

The construction, operation, and concurrent reclamation of the dry stack facility and other features at the tailings management site, as described in the sections *Tailings Management Site*, and *Water Management Plan*, some portion of the tailings management site would receive direct precipitation to open areas of the facility. This precipitation would be captured by contact water or industrial stormwater systems, routed to the contact water or industrial stormwater storage for use in the process, and would no longer contribute to the adjacent surface water hydrologic system (except during infrequent industrial stormwater discharge events), essentially removing watershed area from affected streams. Concurrent reclamation of the dry stack facility would reduce the amount of captured precipitation; however, some precipitation would be lost over the operational period. Containment and rerouting of stormwater is expected to have a negligible effect on surface water quality. No future scope is proposed to address this issue.

Precipitation captured at the tailings management site would result in a deficit of runoff available to the surface water system. The lost precipitation would be a temporary effect and would end once the mining and tailings disposal were terminated at which point precipitation would be routed back to the adjacent watersheds via the dry stack facility cover system and diversion system. Impacts from the lost precipitation contribution to adjacent surface water systems may include reduced stream flows under a variety of flow conditions, indirect effect locally on surface water contribution to wetlands and reduction in flow to Birch Lake. Keeley Creek is near the southern boundary of the tailings management site and may be most influenced.

As the dry stack facility is constructed and once it is completed, precipitation intersecting the cover system and the diversion system would be routed back to undisturbed terrain. This rerouting would result in changes to runoff and stream flow contributions. Following final reclamation, precipitation would be diverted back to the natural surface water system via the cover system and diversion network. Some additional loss may occur via evapotranspiration from the cover system due to the cover soil and vegetation.

Overall, the Project features would result in different drainage patterns and routing characteristics as compared to baseline conditions. The total volume of surface water contribution would remain largely unchanged; however, routing characteristics would be modified permanently. Small changes to down-gradient stream flow and water quality may occur but would be expected to return to a stabilized, equilibrated surface water flow system similar to baseline conditions. These effects to the baseline conditions are anticipated to be minor as the precipitation component would not be lost (excepting potential increase in evapotranspiration) and the diversion system would be designed to work in concert with the local surface water hydrologic system. The very low topographic and stream channel gradients in the area are expected to further minimize stream channel effects.

The fully reclaimed dry stack facility would include the use of surface water management features to control erosion, slope stability, and stormwater quality, quantity, and rates. Per state requirements, drainage from the dry stack facility would also be reintegrated into the natural watershed within three years of the start of closure. Reclamation design would aim to create conditions where runoff rates and volumes are similar to runoff reaching downstream surface water features and defined baseline site conditions. Post-closure grading plans and drainage features would be designed to minimize concentrated flow and limit flow velocities such that, together with the vegetated cover, the resulting site would be stabilized with erosion potential generally similar to baseline site conditions. Related effects to groundwater recharge are also expected and described in Section 6.2.2, the section *Changes in Groundwater Recharge Associated with the Tailings Management Site Contact Water and Industrial Stormwater Management*.

6.2.1.5 Non-Contact Water Management – Diversion of Non-Contact Surface Water Effects

As described in the section *Non-contact Water Diversion Area*, precipitation falling on the watersheds upgradient from the plant site and the tailings management area would be diverted and routed to streams and drainage ways that flow to Birch Lake. The diversion system would result in changes to the surface water system. These changes may include alteration of stream flow properties such as changes to timing of peak flows, maximum and minimum flow rates, inducement of channelized flow, and modification of channelized velocities. These are referred to as routing characteristics. The potential effects to the baseline conditions are anticipated to be minor as the diversion ditches would be designed for appropriate slope, sufficient channel width, and rip rap to prevent scouring, erosion, and sediment contribution. BMPs would also be employed during construction to minimize erosion and sedimentation. The total volume of surface water entering waterways would remain largely unchanged, however, routing characteristics would be permanently modified. This change may also have a permanent indirect effect locally on surface water contribution to wetlands. Containment and rerouting of runoff is expected to have a negligible effect on surface water quality. No future scope is proposed to address this issue.

6.2.1.6 Access Road, Water Intake Corridor, and Transmission Corridor Effects on Surface Water Runoff

Construction activities and vehicular travel within the transmission and water intake corridors and the access roads would result in slight changes to the baseline surface water runoff conditions. Changes in surface cover composition, compaction, and grades related to the transmission and water intake corridors and access roads modifications would slightly alter precipitation runoff characteristics during the period of mine operations / transmission and water intake corridors / access road use. The use of standard BMPs related to road design, construction methods, and continued maintenance would minimize effects to runoff. An integral part of road installation would involve the design and construction of water conveyance infrastructure (such as culverts, road grade requirements, crowning, lateral conveyance features, and water bars) to maintain uninterrupted surface water flow.

6.2.1.7 Surface Water Impacts Summary

Available information to fully assess potential Project impacts to surface water is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- Impacts due to water withdrawal from Birch Lake – Potential effects to Birch Lake include changes to the lake level. Due to the small amount of water use under consideration and the water management practices of the Winton Hydroelectric Station, measurable changes to reservoir levels would not be anticipated. Any effects to Birch Lake would be temporary, limited to the Project operations period;
- Hydrologic impacts due to contact water, industrial stormwater, and non-contact water management - Plant site and tailings management site contact water and industrial stormwater management would result in a loss of contributing precipitation and likely cause a reduction in stream flow and Birch Lake water levels. The net effect would be expected to be minimal as the impact would be temporary and limited to the period of mining operations;
- Rerouting of runoff around the plant site and tailings management site components of the Project would cause a change in surface water conveyance potentially including changes to routing characteristics, stream channel properties, streamflow distribution, and surface water quality. The combined effects of loss and rerouting would be expected to be minimal. Most of this rerouting would be temporary, limited to the Project operations period. However, in the vicinity of the tailings management site the surface water system would be permanently modified;
- Surface water quality impacts due to non-contact water management – Containment and rerouting of runoff is anticipated to have negligible impact on surface water quality as non-contact water runoff water quality will be generally consistent with natural background water quality and conveyance ditches and outlets are designed with BMPs to reduce scour and erosion potential and TSS. Any effect would be temporary, limited to the Project construction and operation periods and thus is not further considered; and

- Surface water impacts due to land use changes in the corridors - Construction activities and vehicular travel within the access roads, water intake corridor and transmission corridor would result in slight changes to the baseline surface water runoff conditions. The available information is adequate to make a reasoned decision about the potential for, and significance of, the surface water impacts due to the land use changes in the corridors. Potential effects to surface water resources are anticipated to be negligible.

Future work to assess potential impacts to surface water is outlined in Section 6.3.1.

6.2.2 Groundwater

6.2.2.1 Depressurization Effects and Groundwater Loss from Adjacent Bedrock HGUs Caused by Underground Mine Dewatering

As the declines and underground mine are developed, groundwater from the shallow and deep bedrock HGUs would be encountered. Groundwater contributions from the QUM unconsolidated materials are not expected as the QUM would be sealed with a collar during construction. The groundwater potentiometric surface associated with the bedrock HGUs would be expected to be encountered within approximately 10 ft of the ground surface. Once groundwater was encountered, it would flow into the underground workings and would be dewatered as described in the section *Water Management Plan*.

A result of mine dewatering would be the potential depressurization of adjacent bedrock. As the shallow and deep bedrock HGUs are depressurized during excavation, a cone of depressurization would occur in the adjacent bedrock HGUs. The cone of depression would extend to the bottom of the deepest mine working and radiate outward to a distance controlled by bedrock hydraulic properties. This depressurized zone would be temporary during Project operation and once mining activities were complete and dewatering was terminated, the groundwater system would be expected to recover and return to approximate pre-mining conditions. The extent of the cone of depressurization would be limited due to the very low hydraulic conductivity of the bedrock and would not be expected to extend substantially into the QUM.

In addition, dewatering of the underground mine during construction and operation would remove groundwater from storage and would transfer the removed groundwater into the contact / process water management system. This would result in a reduction of groundwater to the hydrologic system in the vicinity of the underground mine. The baseline groundwater conditions would be temporarily affected as long as dewatering occurs and until recovery allows the system to return to approximate pre-dewatering saturation and flow conditions.

Overall, effects to the groundwater system are anticipated to be minimal and limited to the immediate sub-basins adjacent to the underground mine area.

Mine dewatering during Project construction, operation, and the post-mining equipment recovery period would have an effect on local groundwater balance and the bedrock potentiometric surface.

6.2.2.2 *Groundwater Quality Effects Due to Flooded Underground Mine*

Mine dewatering would occur during construction and operations to keep the mine dry. During mine dewatering, the groundwater gradient would be temporarily directed towards the underground mine. During Project closure, the underground workings would flood, and groundwater conditions would return to approximate pre-Project conditions. This flooding process would be expected to take a substantial period of time due to the very low hydraulic conductivities of the bedrock.

As the underground workings flood, groundwater would contact unmined surfaces, waste rock backfill, and engineered tailings backfill. This could affect groundwater quality. Groundwater that had contacted unmined surfaces, waste rock backfill, and engineered tailings backfill would eventually migrate away from the mine in flow patterns similar to baseline conditions. As groundwater from the flooded mine mixes with adjacent groundwater, groundwater quality changes could occur. However, substantive changes are not expected in groundwater quality at distances away from the mine due to the very low hydraulic conductivity of the bedrock. Groundwater quality in the re-saturated system would be expected to eventually return to equilibrium exhibiting similar properties to baseline conditions. Future scope will evaluate potential impacts to groundwater quality from the flooded underground mine.

Overall, mine flooding would be expected to have a minimal effect on adjacent groundwater quality.

6.2.2.3 *Changes in Groundwater Recharge Associated with the Plant Site Contact Water and Industrial Stormwater Management*

The plant site contact water management system and industrial stormwater management system would capture precipitation falling on the contact water area and industrial stormwater areas of the plant site for use as process water, as described in the section *Water Management Plan*. As such, the portion of this water that originally recharged the shallow groundwater system would be lost during the operation of the plant site. Due to the higher hydraulic conductivity in the QUM relative to bedrock, the QUM would be most impacted by this effect and possibly be reflected in effects to surface water features in contact with the QUM (such as surface water bodies, streams, and wetlands).

Effects to resources which interact with groundwater within the QUM may include changes to stream flow characteristics, surface water body contributions, and wetland hydrologic functions.

These effects would be temporary and limited to the period of Project construction and operation of the plant site during mining. During Project closure and reclamation, recharge to groundwater would be expected to return to approximate baseline conditions.

The loss of groundwater recharge from the containment of contact water and industrial stormwater at the plant site would be expected to have a minor, temporary effect on the shallow groundwater system in the immediate area of the plant site.

6.2.2.4 Changes in Groundwater Recharge Associated with the Tailings Management Site Contact Water and Industrial Stormwater Management

The construction, operation, and reclamation of the dry stack facility and tailings management site as described in the section *Tailings Management Site* would likely result in a reduction of recharge to local QUM groundwater.

Active portions of the dry stack facility and other areas within the tailings management site would capture and contain precipitation, removing it from the hydrologic system. This lost precipitation would result in a small deficit of recharge available to the groundwater system, primarily to the QUM but also a limited amount to the shallow bedrock, and would affect groundwater movement and the local potentiometric surface.

Precipitation landing on reclaimed portions of the dry stack facility during dry stack facility operation, reclamation, and post-closure, would be diverted back to undisturbed terrain. This diversion of precipitation would result in changes to groundwater recharge, groundwater movement, and the local potentiometric surface. These effects would be permanent but are expected to be localized to the dry stack facility area since that the source would be rerouted rather than lost.

Effects to resources which interact with groundwater within the QUM may include changes to stream flow characteristics, surface water body contributions, and wetland hydrologic functions.

Overall, the loss of groundwater recharge due to containment and diversion of precipitation would result in an effect to the shallow groundwater regime in the dry stack facility area.

6.2.2.5 Groundwater Effects Summary

Available information to fully assess potential Project impacts to groundwater is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- Impacts due to mine dewatering – A cone of depressurization would be caused by mine dewatering in adjacent bedrock and groundwater contributions to adjacent hydrologic system may be reduced. The projected effects would be temporary and would be expected to return to approximately baseline conditions after mining activities cease. The magnitude of the expected effects would be significantly reduced by the very low hydraulic conductivities in the bedrock units and associated limited ability of the bedrock to transmit water. Interaction between the QUM and bedrock HGUs would also be expected to be reduced due to the low hydraulic conductivity of the bedrock;

- Impacts due to mine flooding and resulting mixing with adjacent groundwater – Groundwater flow and elevation conditions would be expected to return to approximate baseline conditions once fully flooded conditions were achieved. Once groundwater flow conditions were restored, flooded mine water would mix with adjacent groundwater. After an initial mixing period, equilibrium would also be expected to occur. Given the very low hydraulic conductivity of the bedrock, any groundwater quality impacts would be expected to be limited to the immediate vicinity of the underground mine; and
- Impacts due to the loss of groundwater recharge associated with containment of precipitation from surface facilities – The effects of precipitation lost from groundwater recharge would be temporary at the plant site and localized at the dry stack facility. Since the direct effect would be related to QUM recharge, surface water features within the QUM such as stream flow, lake contributions, and wetlands hydrologic functions could be affected.

Further work to assess potential impacts to groundwater is outlined in Section 6.3.2.

6.2.3 Wetlands

Direct impacts to wetlands would occur within the areas of potential ground disturbance of the Project. Wetland impacts would be due to clearing, filling, and grading activities. The compact size of the plant site, the use of underground mining methods, the selection of the dry stack facility design, and the close proximity to each other are all designed to minimize the direct impact foot print of the Project. The Project would specifically site supporting infrastructure, such as the water intake corridor and ventilation raise sites / access road, to avoid direct wetland impacts. Additionally, measures would be taken to minimize impacts. For example, the transmission corridor would limit direct wetland impacts by limiting construction in wetland crossings to only winter months when the ground is frozen and vegetation is dormant. Also, within the transmission corridor the two-track access and the power poles would be sited, to the extent practical, to avoid wetlands. Estimated total direct wetland impacts from the Project based on NWI data would be 155.9 acres (63.1 ha) which represents 9% of the wetland in the Project area.

Direct impacts within the areas of potential ground disturbance would be permanent. Estimated direct impacts based on NWI data are shown in Table 6-31 through Table 6-46.

In addition to direct impacts, there is potential for the Project to cause indirect wetland impacts. The construction of the plant site and the tailings management site would potentially fragment wetlands and the water management systems would also potentially impact wetland hydrology and wetland recharge. Mine development and mine dewatering could lower the water table and impact wetlands near the underground mine. However, this impact may be attenuated as the wetlands in the Project area typically contain a lower layer of peat or other fine-grain sediments with very low hydraulic conductivity negating the effects of dewatering.

Additionally, there could be indirect impacts due to atmospheric deposition from dust emissions. These indirect impacts are reduced by Project design, specifically:

- Conducting crushing activities underground;
- Reduced surface footprint to reduce indirect impacts;
- Sealing of the decline in the QUM reducing any potential groundwater draw down in the area of the decline; and
- Concurrent reclamation of the dry stack facility which minimizes the area exposed and EPMs including water trucks to reduce fugitive dust from the plant site and tailings management site.

Table 6-31 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Project Area

Wetland Type	Project Direct Impacts (acres)[1]
Artificially Flooded	0.0
Coniferous Bog	76.2
Deep Marsh	0.0
Hardwood Swamp	19.0
Non-Vegetated Aquatic Community	19.6
Open Bog	5.4
Seasonally Flooded/Saturated Emergent Wetland	1.9
Shallow Marsh	17.9
Shallow Open Water Community	0.0
Shrub-Carr Wetland	16.1
Total	156.1

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-32 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Plant Site

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	2.7
Hardwood Swamp	7.2
Non-Vegetated Aquatic Community	0.1
Open Bog	0.2
Seasonally Flooded/Saturated Emergent Wetland	0.0
Shallow Marsh	0.5
Shallow Open Water Community	0.0
Shrub-Carr Wetland	0.6
Total	11.3

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-33 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Tailings Management Site

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	47.0
Hardwood Swamp	8.8
Non-Vegetated Aquatic Community	5.6
Open Bog	4.7
Seasonally Flooded/Saturated Emergent Wetland	0.0
Shallow Marsh	11.0
Shallow Open Water Community	0.0
Shrub-Carr Wetland	11.8
Total	88.9

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-34 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Access Road

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	0.9
Hardwood Swamp	0.0
Non-Vegetated Aquatic Community	0.0
Open Bog	0.0
Seasonally Flooded/Saturated Emergent Wetland	0.1
Shallow Marsh	0.0
Shallow Open Water Community	0.0
Shrub-Char Wetland	0.6
Total	1.6

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-35 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Transmission Corridor

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	12.8
Hardwood Swamp	1.3
Non-Vegetated Aquatic Community	5.8
Open Bog	0.5
Seasonally Flooded/Saturated Emergent Wetland	1.8
Shallow Marsh	4.7
Shallow Open Water Community	0.0
Shrub-Carr Wetland	2.1
Total	29.0

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-36 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Water Intake Corridor

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	0.0
Hardwood Swamp	0.2
Non-Vegetated Aquatic Community	0.0
Open Bog	0.0
Seasonally Flooded/Saturated Emergent Wetland	0.0
Shallow Marsh	0.0
Shallow Open Water Community	0.0
Shrub-Carr Wetland	0.0
Total	0.2

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-37 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Ventilation Raise Sites and Access Roads

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	0.4
Hardwood Swamp	0.0
Non-Vegetated Aquatic Community	0.0
Open Bog	0.0
Seasonally Flooded/Saturated Emergent Wetland	0.0
Shallow Marsh	0.0
Shallow Open Water Community	0.0
Shrub-Carr Wetland	0.0
Total	0.4

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-38 Minnesota National Wetland Inventory Simplified Plant Community Classification Estimated Impacts for the Non-Contact Water Diversion Area

Wetland Type	Project Direct Impacts (acres)[1]
Coniferous Bog	12.4
Hardwood Swamp	1.5
Non-Vegetated Aquatic Community	8.1
Open Bog	0.0
Seasonally Flooded/Saturated Emergent Wetland	0.0
Shallow Marsh	1.7
Shallow Open Water Community	0.0
Shrub-Carr Wetland	1.0
Total	24.7

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-39 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Project Area

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	1.9
Type 3 Shallow Marsh	17.9
Type 4 Deep Marsh	8.2
Type 5 Shallow Open Water	10.5
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	16.1
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	19.0
Type 8 Bogs; Coniferous Bogs, Open Bogs	81.6
90 Rivers and streams	0.8
Municipal-Industrial	0.0
Total	156.0

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-40 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Plant Site

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	0.0
Type 3 Shallow Marsh	0.5
Type 4 Deep Marsh	0.0
Type 5 Shallow Open Water	0.1
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	0.6
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	7.2
Type 8 Bogs; Coniferous Bogs, Open Bogs	2.9
90 Rivers and streams	0.0
Total	11.3

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-41 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Tailings Management Site

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	0.0
Type 3 Shallow Marsh	11.0
Type 4 Deep Marsh	0.4
Type 5 Shallow Open Water	5.2
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	11.8
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	8.8
Type 8 Bogs; Coniferous Bogs, Open Bogs	51.7
90 Rivers and streams	0.0
Total	88.9

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-42 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Access Road

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	0.1
Type 3 Shallow Marsh	0.0
Type 4 Deep Marsh	0.0
Type 5 Shallow Open Water	0.0
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	0.6
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	0.0
Type 8 Bogs; Coniferous Bogs, Open Bogs	1.0
90 Rivers and streams	0.0
Total	1.7

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-43 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Transmission Corridor

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	1.8
Type 3 Shallow Marsh	4.7
Type 4 Deep Marsh	0.0
Type 5 Shallow Open Water	4.9
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	2.1
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	1.3
Type 8 Bogs; Coniferous Bogs, Open Bogs	13.2
90 Rivers and streams	0.8
Total	28.8

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-44 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Water Intake Corridor

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	0.0
Type 3 Shallow Marsh	0.0
Type 4 Deep Marsh	0.0
Type 5 Shallow Open Water	0.0
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	0.0
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	0.2
Type 8 Bogs; Coniferous Bogs, Open Bogs	0.0
90 Rivers and streams	0.0
Total	0.2

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-45 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Ventilation Raise Sites and Access Road

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	0.0
Type 3 Shallow Marsh	0.0
Type 4 Deep Marsh	0.0
Type 5 Shallow Open Water	0.0
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	0.0
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	0.0
Type 8 Bogs; Coniferous Bogs, Open Bogs	0.4
90 Rivers and streams	0.0
Total	0.4

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 6-46 Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Estimated Impacts for the Non-Contact Water Diversion Area

Wetland Type	Project Direct Impacts (acres)[1]
Type 1 Seasonally flooded basins or flats	0.0
Type 2 Wet Meadows	0.0
Type 3 Shallow Marsh	1.7
Type 4 Deep Marsh	7.8
Type 5 Shallow Open Water	0.3
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	1.0
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	1.5
Type 8 Bogs; Coniferous Bogs, Open Bogs	12.4
90 Rivers and streams	0.0
Total	24.7

Notes:
Source for Rainy River Headwater wetland data is: Robb D. Macleod, Robert S. Paige, and Alek J. Kreiger, 2016. Updating the National Wetland Inventory in Northeast Minnesota: Technical Documentation. Ducks Unlimited, Inc.
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

6.2.3.1 Compensatory Wetland Mitigation

Future work would be done to complete wetland delineations and assess the requirements for compensatory wetland mitigation including probable mitigation ratios, mitigation approaches, and potential banking sites. Impacts to wetlands would require a permit from the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act and from the MDNR under the requirements of Minnesota's Wetland Conservation Act (WCA). The Section 404 Clean Water Act permit would also include Section 401 Clean Water Act Water Quality Certification, which is coordinated with the MPCA.

The Project has completed preliminary wetlands surveys, but has not completed wetland delineations and has not yet identified a conceptual wetland mitigation plan. The future wetland identification and delineation scope is discussed in Section 6.3.3 and wetland mitigation plans would be developed and submitted for approval to compensate for the expected impacts.

6.2.3.2 Wetlands Impacts Summary

Available information to fully assess potential Project impacts to wetlands is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- Direct impacts to wetlands would occur due to Project construction, specifically clearing, grading, and filling; and

- The Project could result in potential indirect impacts to wetlands due to wetland fragmentation, changes in wetland hydrology and recharge, and dust deposition.

Future work to assess potential direct or indirect impacts to wetlands is included as part of the surface water and groundwater future scopes of work, outlined in Section 6.3.1 and Section 6.3.2. Further work on wetland delineation and monitoring is described in Section 6.3.3.

6.3 Future Scope

6.3.1 Surface Water Supplemental Scope

6.3.1.1 Surface Water Supplemental Scope Purpose

Supplemental data acquisition and analysis will better define the surface water baseline environmental conditions, hydrologic regime, surface water / groundwater interactions and relationships, and potential Project impacts to the surface water system. Additional data collection will occur related to supplemental surface water sampling and testing locations, sample frequency, parameters to be measured, establishment of instrumented stations, and collection of geomorphologic information. The information collected will be used to further define baseline conditions and develop conceptual models for the surface water systems. The conceptual model will guide analysis of hydrologic features though the combined use of appropriate data characterization, analytical solutions and models, analog evaluations, stochastic models, numerical models, and dynamic systems modeling to simulate existing baseline hydrologic conditions and simulate the effects to the baseline conditions that could result from the Project. Additionally, this work will inform Project design by suggesting design options or EPMs to reduce potential impacts from the Project to the greatest extent possible.

6.3.1.2 Surface Water Supplemental Scope Questions to be Answered

The scope of work outlined in the following subsections has been developed to address the following scoping elements:

- What are the nature and extent of potential impacts to surface water hydrology, stream morphology, and surface water quality and quantity?
- Are there potential impacts that are significant, and can Project EPMs or reduction methods be identified to reduce the significance of any impacts to surface water hydrology and water quality and quantity identified?

Accordingly, based on the anticipated surface water impacts described in Section 6.2.1 and other potential surface water impacts that could result from the Project, the following specific questions will be addressed:

- Will the Project design features, operating protocols, and the resulting water balance model confirm that a direct discharge of process water or contact water will not be anticipated?

- How will water appropriation, contact water management, industrial stormwater management, non-contact water management, and mine dewatering affect the Birch Lake water level or hydrologic system?
- How will contact water management, industrial stormwater management, and non-contact water management affect surface water flows and stream morphology of Keeley and Nokomis Creeks?
- Could the management of process water, mixed water, and contact water result in impacts to water quality in area streams (Keeley and Nokomis Creeks) or Birch Lake and if so, to what extent?
- Could the flooded underground workings in closure result in impacts to water quality in area streams or Birch Lake and if so, to what extent?
- Could dust deposition from the dry stack facility and other mine features impact water quality in area streams or Birch Lake, and if so, to what extent?
- Are the classifications of water types into water management categories consistent with applicable regulatory requirements?
- Could there be surface water quality impacts from the storage of peat?

6.3.1.3 Surface Water Supplemental Scope Approach

Phase 1 – Supplemental Data Collection. Although TMM has obtained and developed a substantial database with respect to surface water hydrology, additional information is needed to evaluate potential impacts to the surface water hydrologic system. Instrumented gaging stations will be installed to further define the flow regime in Keeley Creek upstream and downstream of the tailings management site. Flow measurement frequency of existing grab sample locations will be increased. Supplemental information will be obtained regarding stream channel morphology and watershed characteristics to allow simulation of future expected conditions.

Phase 2 – Water and Mass Balance Model. A water balance model will be developed using the commercial simulation software GoldSim™. The water balance model will include the simulation of process water flow, including water gains and losses and consumptive use, contact water management, industrial stormwater management, and construction stormwater from Project features during construction, operations, closure, and post-closure. Modeling will consider the effects of climate variability and uncertainty on the Project water balance through stochastic modeling. The water balance model will combine and integrate results from other modeling efforts (groundwater modeling and modeling of the dry stack facility for example) in order to quantify the make-up water demands for the Project, quantify the amount of contact water and stormwater that will need to be managed by the Project, and to inform various aspects of the evaluation of the impacts of the Project on water resources. In addition, the model will also be used to demonstrate that the Project will not discharge any process water and is designed not to require a discharge of contact water.

The GoldSim™ model will also be used as a mass balance model to aid in the estimation of the quality of the process water, mixed water, and contact water that will be managed as part of the Project.

Phase 3 – Surface Water Hydrology Model. The evaluation of the impacts of the Project on surface water features will be assessed. The U.S. Army Corps of Engineers HEC-HMS software program will be used to simulate runoff at the North Nokomis Creek (Kittle Number: H 001 092 017.4), South Nokomis Creek (Kittle Number: H-001-092-017.2), Filson Creek and Keeley Creek outlets. The HEC-HMS model will be run in a continuous mode to simulate daily runoff at the watershed outlets. The models will be calibrated to observed runoff at Keeley Creek and Filson Creek. The model will be used to assess how the Project could affect the flow duration curves within each of the four creeks.

Potential impacts of the Project on the water balance of Birch Lake reservoir will also be assessed. The inflows to the Birch Lake reservoir will be estimated using the available baseline data and results from the HEC-HMS model. Outflow from the reservoir will be the measured flow at the USGS gage downstream of the Birch Lake reservoir. Precipitation to and evaporation from the lake surface will be estimated using available climate data. Potential impacts of the Project on Birch Lake reservoir will be assessed using the results of the HEC-HMS model.

Phase 4 – Surface Water Quality Modeling. As was previously discussed, it is unlikely that the Project will result in water quality impacts to area streams and Birch Lake; however, the potential for impacts will be considered.

Potential pathways for how process water, mixed water, and/or contact water could be released to surface waters will be considered and then quantified. Pathways that could be considered are leakage from process water, mixed water, and contact water ponds, leakage from the dry stack facility, flow from flooded mine workings in closure, unique project-related conditions (such as, system failures, up-set conditions, storage overtopping, etc.) and dust deposition. These pathways will include assessing the potential for run-off from roadways and resulting impacts.

For pathways that are carried forward, mixing calculations will be performed as a screening step to assess the potential impact to surface waters. This will require estimates of the quality of water associated with each pathway, which will be based on the geochemical conceptual model developed for the Project. This model will also assess potential contamination at the Project – mixed water and contact water pond liners, soils, and road – that would need remediation during reclamation. If the screening level mixing calculations suggest a measurable impact could occur, more sophisticated modeling could be conducted.

Phase 5 – Submission of Technical Memoranda and Hydrology Reports. A series of interim summary reports and technical memorandums will be prepared to present Work Plans, quality assurance / quality control protocols, laboratory and field data, data analysis, and hydrologic system interpretations associated with the surface water hydrologic system. Standard professionally accepted data collection, analysis, and modeling techniques and protocols will be used as pre-defined in specific work plans. The interim reports and technical memorandums will serve as references to the primary deliverables consisting of four Hydrological Characterization Reports as follows:

- Hydrology Characterization Data Package Volume 1;
- Hydrology Characterization Baseline Conditions Volume 2;
- Hydrology Characterization Conceptual Model and Impact Analysis Methods Volume 3; and
- Hydrology Modeling Results and Cumulative Assessment of Project Effects Volume 4.

Volumes 1 through 4 are anticipated to evolve and be updated throughout the environmental review and permitting processes as supplemental information and analysis become available.

6.3.1.4 Surface Water Supplemental Scope Deliverables

Hydrology Characterization Data Package Volume 1. A review and validation of data will be conducted within this report to evaluate the data and its usability to support environmental assessments as the Project moves into state and federal processes for environmental review and permitting. Climatological, geological, hydrogeological, groundwater quality, surface water quality, and surface water flow will be evaluated through the validation processes described within this report. For each data type, an individual qualifying criteria matrix will be developed to document data quality review, and to identify potential qualifiers that should be resolved or recognized in the use of the data.

Additionally, Volume 1 will include discussions on relevant regulations including:

- Clean Water Act applicability to surface water;
- MDNR applicability to permitted structures and works in public waters;
- MPCA rules applicability to waters of the state;
- MDH, MPCA and EPA standards applicability to groundwater resources;
- MDH and MPCA permits and water quality requirements; and
- 40 CFR 144.81(8), Class V underground injection well / control requirements.

Hydrology Characterization Baseline Conditions Volume 2. This report will utilize the data documented and validated in Volume 1 to summarize baseline environmental conditions at the Project with respect to surface water, groundwater, climate, and geology. Analysis and interpretations of the validated data set will be used to further define the hydrologic regime associated with the Project area. Baseline interpretations will include:

- Precipitation, and other applicable climatic data;
- Stream and lake characteristics (flow, water quality, water level);
- Groundwater occurrence, movement, and water quality;
- Groundwater and surface water hydraulic and runoff controlling components;
- Surface water / groundwater interactions; and
- Seasonal, temporal, and spatial data variations.

Hydrology Characterization Conceptual Model and Impact Analysis Methods Volume 3. The qualified data and information brought forth in Volume 1, and interpreted in Volume 2 will be further analyzed to present a conceptual model of the hydrologic regime. This document will apply the conceptual model to a set of methodologies designed to analyze, estimate, and quantify potential changes to the hydrologic regime as a result of implementation of the Project. A comparison of the baseline hydrologic conditions to the conditions expected as a result of Project activities will provide an avenue to evaluate potential influences to the surface and groundwater systems. Based on the conceptual models developed for the groundwater, surface water systems, and geochemical considerations from the Project; analytical, analog, stochastic, and numerical models will be specified to simulate existing baseline hydrologic conditions and simulate the response of the baseline conditions as a result of implementation of the Project. The intended outcome of the modeling effort described will be to provide a basis to quantify Project influences on the surface water, groundwater, and cumulative hydrologic regime.

Hydrology Modeling Results and Cumulative Assessment of Project Effects Volume 4. The defined conceptual models and the analysis / modeling methods presented in Volume 3 will be developed as surface water and groundwater numerical models and other analysis methods which reflect Project area conditions. Analysis and modeling of the hydrologic system will include baseline conditions, the mine operational period, and the reclamation / closure period. A no-action alternative will also be simulated. Model domains, input data (from Volume 2), and modeling functions will be constructed to simulate baseline conditions. When reasonable, simulated baseline conditions will undergo a calibration process resulting in models that statistically correspond to measured baseline conditions. Once each model is calibrated, the input information will be modified to reflect Project operations. Selected monitoring points will be assigned to allow specific comparison of baseline and mine operational results for specific parameters such as water level, groundwater basin balance, stream flow, water quality, etc. The models will be run, and Project conditions will be compared to baseline conditions to quantify potential impacts. Various sensitivity analysis will be performed to determine the influence of model input.

6.3.2 Groundwater Supplemental Scope

6.3.2.1 Groundwater Supplemental Scope Purpose

This work will better define the groundwater baseline environmental conditions, hydrogeologic regime, surface water / groundwater interactions and relationships, and Project impacts to the groundwater system. Additional data collection will occur related to the existing groundwater monitoring network, supplemental groundwater locations, construction of supplemental monitoring / test wells, supplemental aquifer testing, geochemical analysis, and further definition of the QUM. The information collected will be used to further develop conceptual models for the groundwater systems. The conceptual model will guide analysis of hydrogeologic features and the development of analytical, analog, and numerical models to simulate existing baseline hydrogeologic conditions and simulate the response of the baseline conditions as a result of implementation of the Project. Additionally, this work will inform Project design to the greatest extent possible in reducing potential impacts resulting from the Project.

6.3.2.2 Groundwater Supplemental Scope Questions to be Answered

Similar to the surface water section, the scope of work outlined in the following subsections has been developed to address the following scoping elements:

- What are nature and extent of potential impacts to groundwater occurrence and movement and groundwater quality?
- Are there potential impacts to hydrogeology that will be significant, and can Project EPMs or reduction methods be identified to reduce the significance?

Accordingly, based on the anticipated groundwater impacts described in Section 6.2.2 and other potential groundwater impacts that could result from the Project, the following specific questions will be addressed:

- What will be the three dimensional extent of the cone of depressurization over the life of dewatering activities (projected groundwater potentiometric surface maps and cross sections)?
- What will be the timeframe and expected rate to initiate and complete flooding of the mine workings?
- How will contact water management, industrial stormwater management, and non-contact water diversion affect groundwater recharge and the potentiometric surface in the shallow groundwater system?
- How will the changes in the potentiometric surfaces affect local streamflow, contribution to Birch Lake and wetlands?
- Will local domestic wells be affected by mining activities?
- Could the management of process water, mixed water, and contact water result in impacts to groundwater quality and if so, to what extent?
- Could the flooded mine workings in closure result in impacts to groundwater quality and if so, to what extent?

6.3.2.3 Groundwater Supplemental Scope Approach

Phase 1 – Supplemental Data Collection. Although TMM has obtained and developed a substantial database with respect to groundwater hydrology, additional information is needed from the existing monitor well network to evaluate potential groundwater impacts to the groundwater hydrologic system. Supplemental monitor wells / test wells and data acquisition from those new locations are needed. The following specific activities are under consideration for implementation:

- Continue to obtain baseline data (generally monthly groundwater levels, and quarterly water quality samples from the existing network of monitor wells);
- Conduct aquifer test analysis on monitor wells which have not been field tested to date;
- Add newly constructed monitor wells to the water level and water quality sampling program;
- Install new monitor wells at selected locations to supplement the current monitor well network - including at the plant site and the tailings management site;
- Conduct aquifer testing at new monitor well locations;

- Add new well locations to the sampling network;
- Define the construction and operating characteristics of the tailings management site;
- Conduct static and kinetic testing of tailings and ore geochemistry; and
- Obtain local domestic well construction and operational details.

Phase 2 – Groundwater Analysis and Flow Modeling. The Project Area groundwater system will be analyzed using a combination of applicable predictive analytical and numerical modeling approaches. First, two conceptual models, will be developed:

- A model of current groundwater conditions at the Project area based on monitor well test results, watershed characteristics, site data collected for the Project, and other publicly-available data sets; and
- A model of future groundwater conditions, representing the effects of the Project during the operation phase and the reclamation and closure phase.

These conceptual models will be used to produce a finite-difference (MODFLOW) numerical groundwater flow model and other analytical or analog models to answer specific questions for the Project area. The numerical model will be capable of assessing changes to the groundwater system based on Project operations, specifically changes to the baseline conditions (represented by a no-action alternative simulation) due to underground mine operations and changes in land-use which can impact aquifer recharge. The model will cover the Project area and sub-regional area of the Project.

Phase 3 - Groundwater Quality Modeling. As was previously discussed, it is unlikely that the Project will result in water quality impacts to groundwater; however, the potential for impacts will be considered.

Potential pathways for how process water, mixed water, and/or contact water could be released to groundwater will be considered and then quantified consistent with surface water analyses. Anticipated pathways that could be considered are leakage from process water and contact water ponds, leakage from the dry stack facility, flow from flooded mine workings in closure, interaction with engineered tailings backfill, unique project-related conditions (such as, system failures, up-set conditions, storage overtopping, etc.) and dust deposition. These pathways will include assessing the potential for precipitation to infiltrate roadways and resulting impacts.

For pathways that are carried forward, mixing calculations or simple analytical methods will be performed as a screening step to assess the potential impact to groundwater. This will require estimates of the quality of water associated with each pathway, which will be based on the geochemical conceptual model developed for the Project. If the screening level mixing calculations suggest a measurable impact could occur, more sophisticated modeling could be conducted.

Phase 4 – Submission of Technical Memoranda and Hydrology Reports. The data acquisition, analysis, and predictive modeling accomplished during the Groundwater Supplemental Scope will be integrated into the appropriated reports.

6.3.2.4 Groundwater Supplemental Scope Deliverables

The result of this work will be delivered through interim data delivery / analysis reports and technical memorandums. The groundwater data, analysis, and simulated hydrologic conditions will be combined with the results from the Section 6.3.1, and will be included in Hydrology Volumes 1 through 4.

6.3.3 Wetlands Supplemental Scope

6.3.3.1 Wetlands Purpose

TMM will conduct wetland delineations in the Project area to identify wetlands and regulatory boundaries and perform functional assessments. Additionally, this work will inform future steps necessary to define potential direct and indirect impacts to wetlands in the Project area.

This delineation will help refine the baseline wetland conditions and identify possible reduction measures that the Project could implement to limit impacts. This work will also inform permit applications, including Minnesota WCA, U.S. Army Corps of Engineers (USACE) Section 404, and MPCA Section 401 Water Quality Certification.

6.3.3.2 Wetlands Questions to be Answered

- What are the wetland extent, quantities, qualities, and classifications in the Project area?
- What are the potential direct and indirect effects regarding wetland water balance and wetland water quality?
- Are there potential impacts to wetlands identified that are significant, and can Project EPMs or reduction methods be identified to avoid, minimize, or mitigate the significance of the impacts?

6.3.3.3 Wetlands Approach

Phase 1 – Desktop Review. This phase will build off the baseline conditions of the SEAW Data Submittal and will include review of the public data. This will include both the spatial extent of wetland in the Project area as well as estimated wetland plant community types. Desktop surveys will be used as the basis for the wetland delineation. Sources reviewed will include:

- USGS topographic maps and digital elevation models;
- USFS ELT soils data;
- NRCS soils data;
- MDNR NWI update mapping;
- USFWS NWI map;
- SNF USFS stand data;
- USGS National Hydrography Data Set;
- MDNR Protected / Public Waters mapping;
- Farm Service Administration aerial photography; and
- Forest Plan maps.

Phase 2 – Wetland Delineations. As part of the future scope of work, an area of analysis will be developed that coincides with wetland resources that may be affected by the Project (both direct and indirect). Wetland delineations will be conducted to identify wetlands, regulatory boundaries, and functional assessments for wetlands identified as part of the EIS area of analysis. The area of analysis will be developed considering the influences to wetland hydrology, soils, and vegetation from Project infrastructure such as: changes to groundwater contributions, changes to surface water contributions, wetland fragmentation, and air deposition.

Phase 3 – Direct and Indirect Impact Data Acquisition and Analysis. After delineation and functional assessment of wetlands in the Project area were complete, further work will be done to define potential indirect impacts to wetlands. This work could include:

- Installing nested piezometers;
- Collecting and measuring undisturbed peat thicknesses and subsurface structure;
- Characterizing wetland water quality; and
- Characterizing wetland seasonal water level variability.

These methods for modeling and monitoring indirect impacts to wetlands will be refined as the future work scope related to surface water and groundwater (Sections 6.3.1 and 6.3.2) are completed.

6.3.3.4 Wetlands Deliverables

The results of Phases 1 to 3 will be combined with the results from the Habitat, Vegetative, Wildlife, and Aquatics Baseline Surveys and will be included in the following reports:

- Wetland and Terrestrial and Aquatic Resources – Volume 1 Baseline Data and Methods;
- Wetland and Terrestrial and Aquatic Resources – Volume 2 Baseline Conditions;
- Wetland and Terrestrial and Aquatic Biology—Volume 3 Impact Assessment Methodology: This volume will provide a description of the methodology used to assess potential effects from changes identified in surface and groundwater hydrology to terrestrial and aquatic resources identified. The methodology will include a decision matrix for how effected resources are determined, how the relevant areal extent is defined, how potential impacts are determined, and the criteria used to determine the magnitude of potential effects; and
- Wetland, and Terrestrial and Aquatic Biology—Volume 4 Potential Impacts and Mitigation: Based on methodology described in Volume 3, potential impacts from the Project will be described. The report will characterize potential effects based on the temporal and areal extent. The report will identify opportunities or approaches that may be available to avoid, minimize, or mitigate the identified potential effects.

- A preliminary wetland replacement plan will be prepared for inclusion in the Draft EIS.

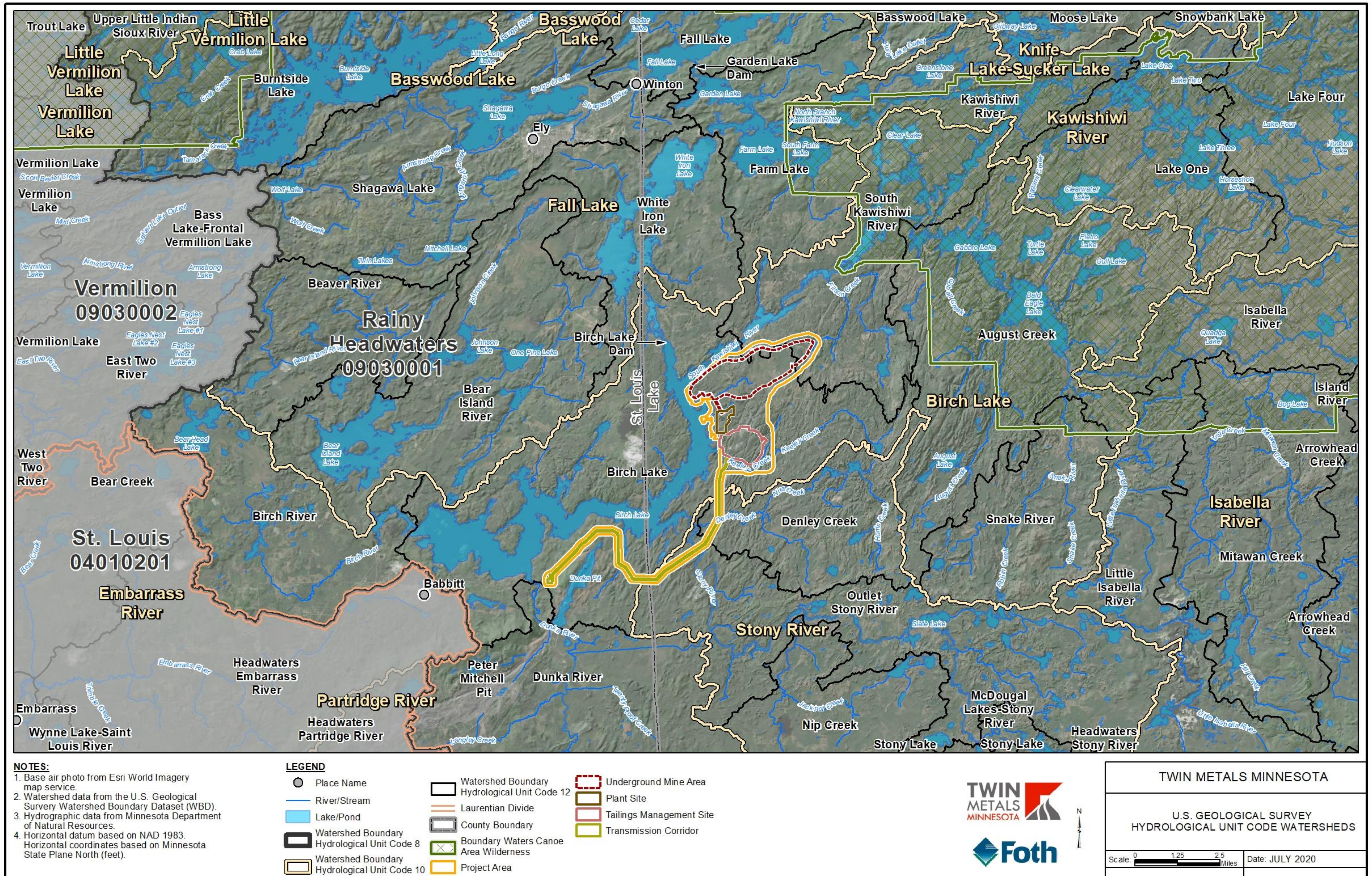


Figure 6-1 U.S. Geological Survey Hydrological Unit Code Watersheds

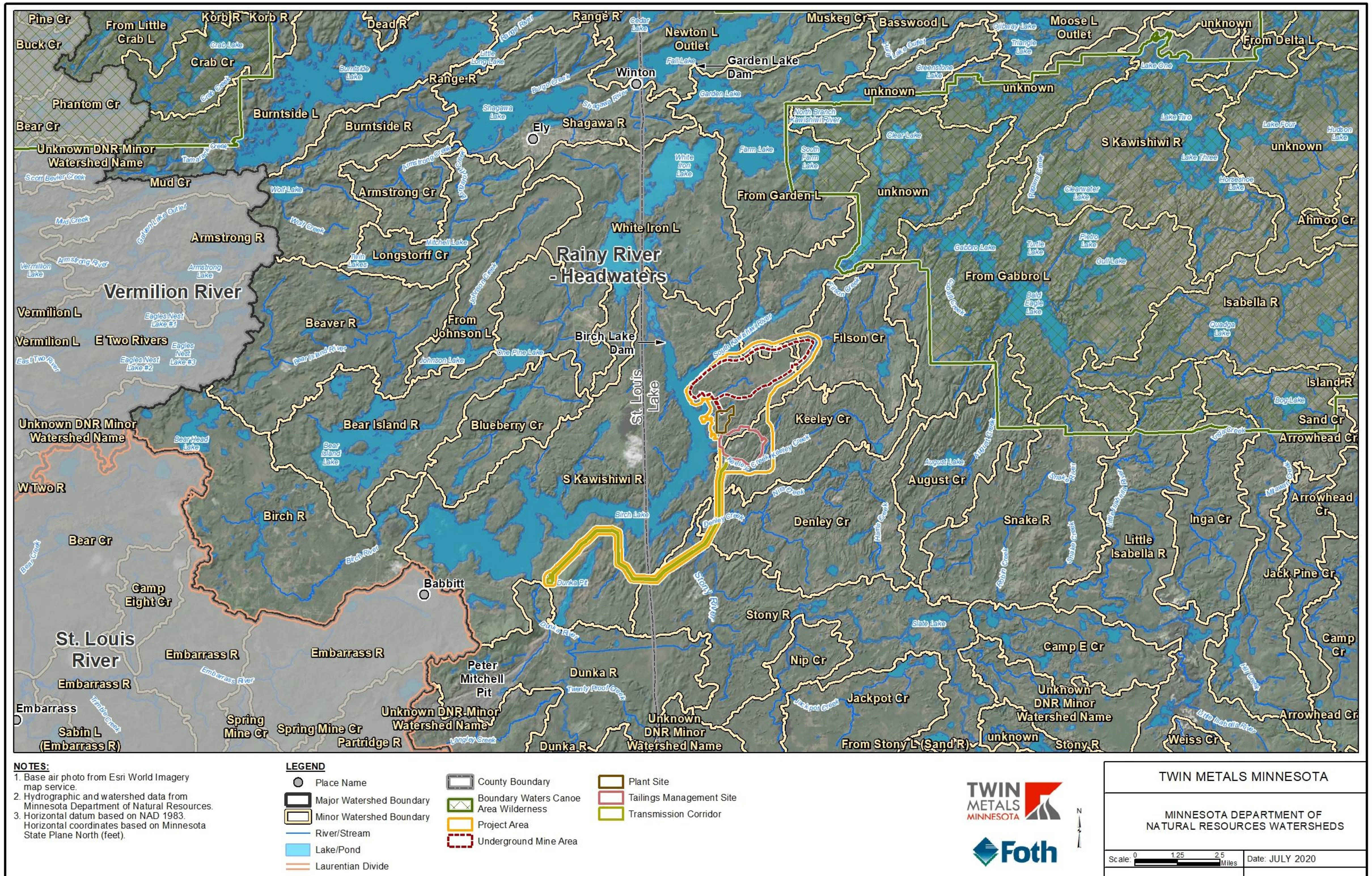
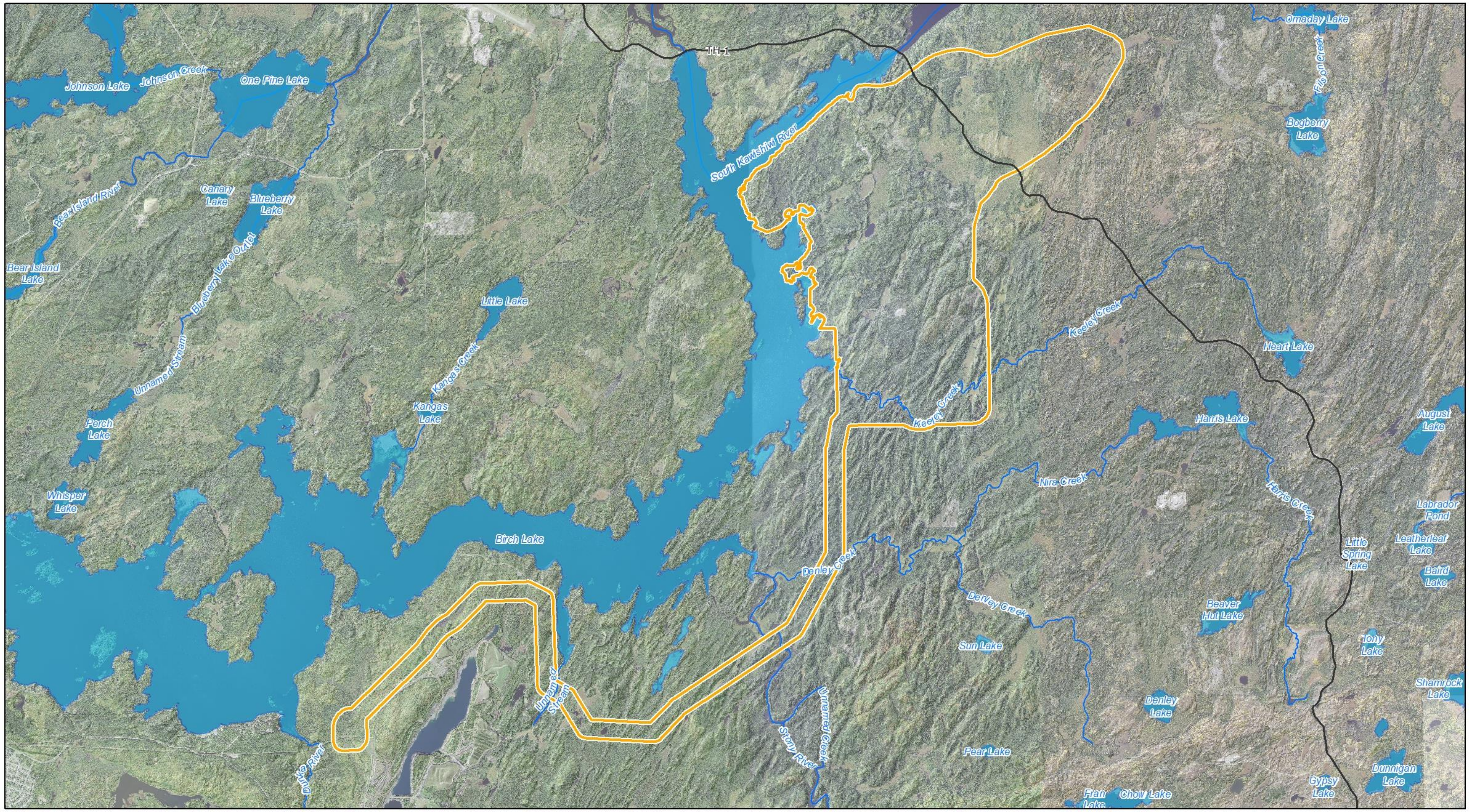


Figure 6-2 Minnesota Department of Natural Resources Watersheds



NOTES:
1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND
- Public Waters - Watercourse Delineation
- Public Waters - Basin Delineation
- Primary Road
- Project Area

TWIN METALS MINNESOTA

MINNESOTA DEPARTMENT OF NATURAL RESOURCES PUBLIC WATER INVENTORY

Scale: 0 2,500 5,000 Feet | Date: JULY 2020

Figure 6-3 Minnesota Department of Natural Resources Public Water Inventory

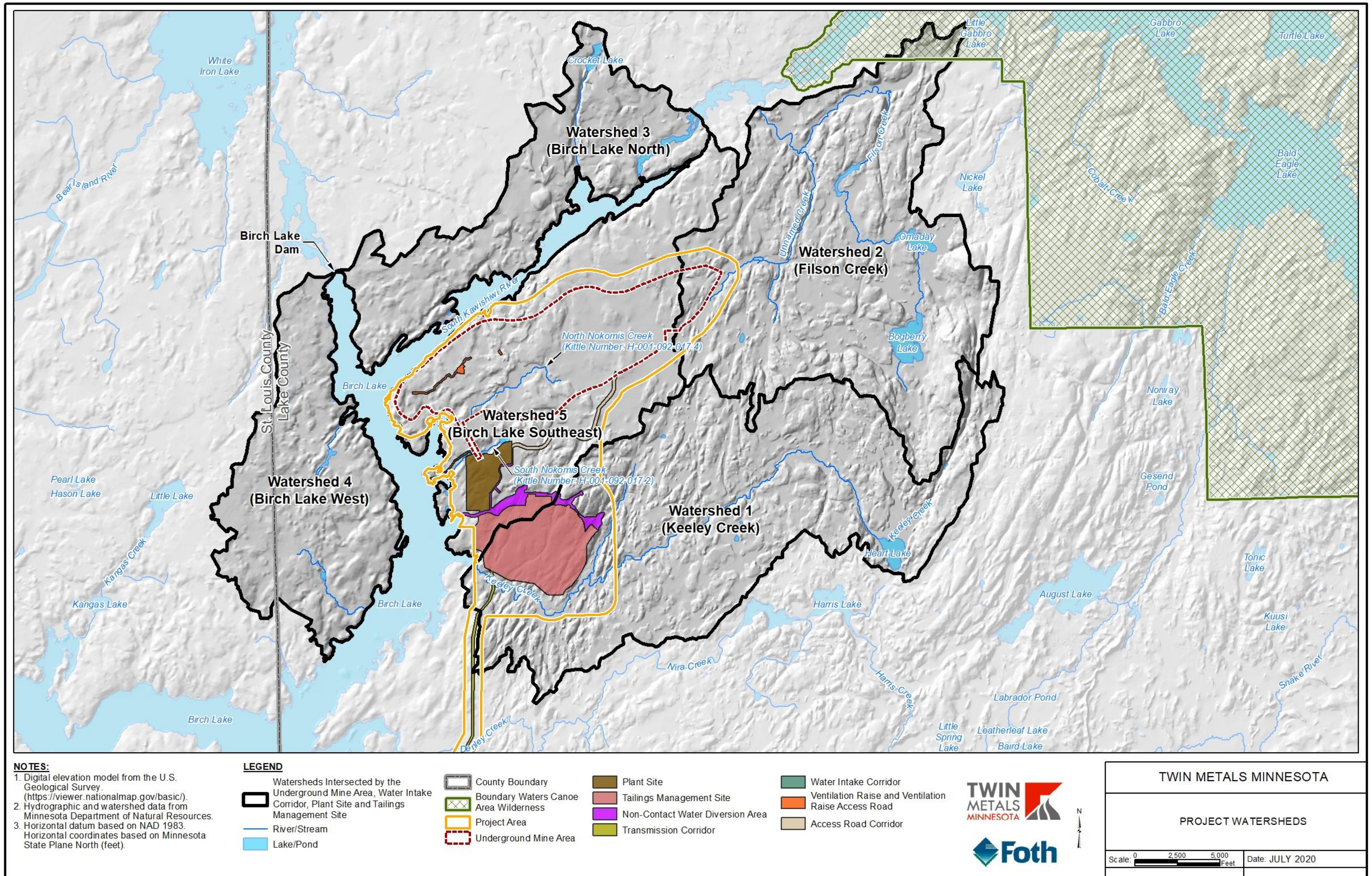


Figure 6-4 Project Watersheds

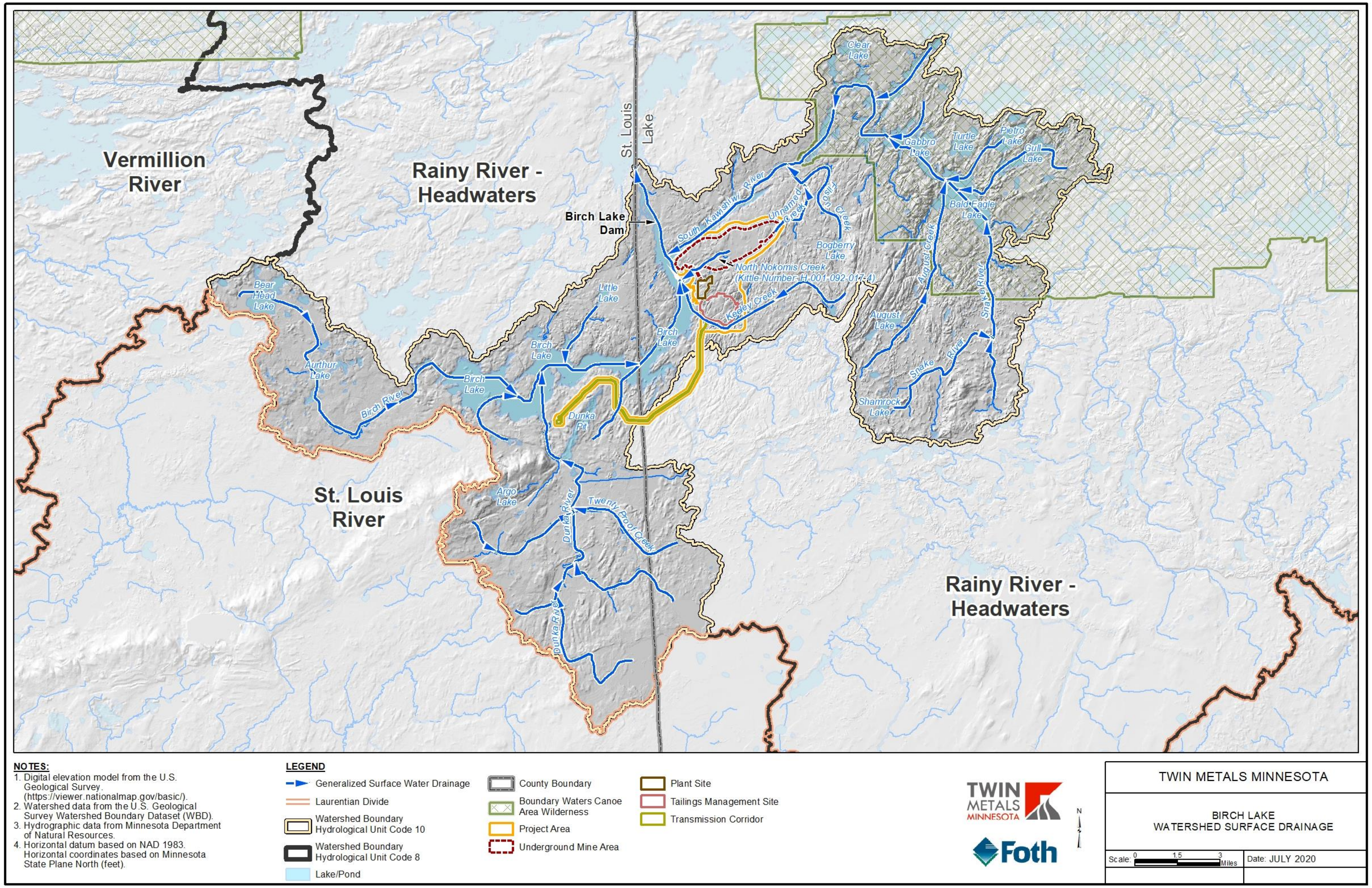


Figure 6-5 Birch Lake Watershed Surface Drainage

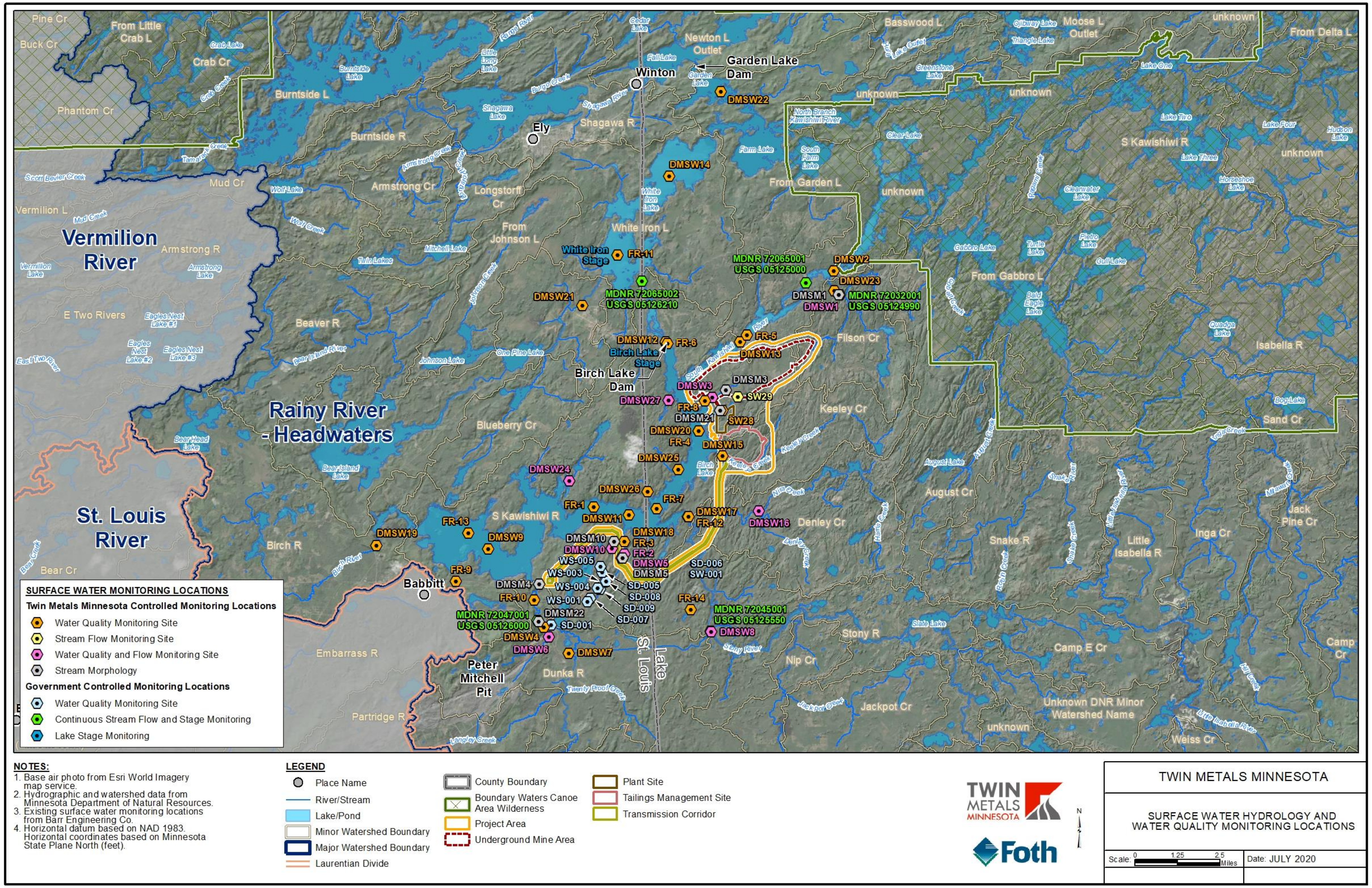


Figure 6-6 Surface Water Hydrology and Water Quality Monitoring Locations

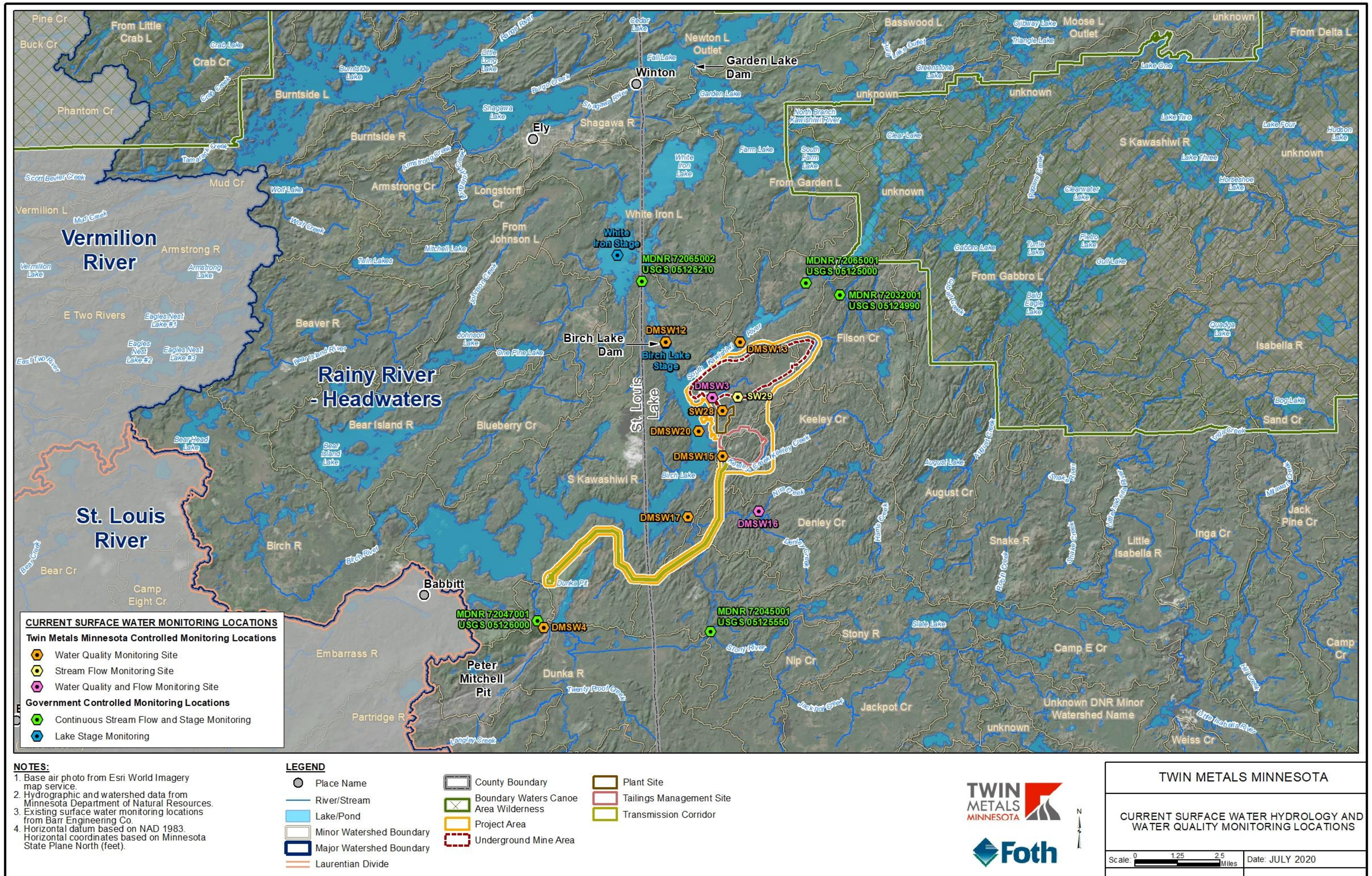


Figure 6-7 Current Surface Water Hydrology and Water Quality Monitoring Locations

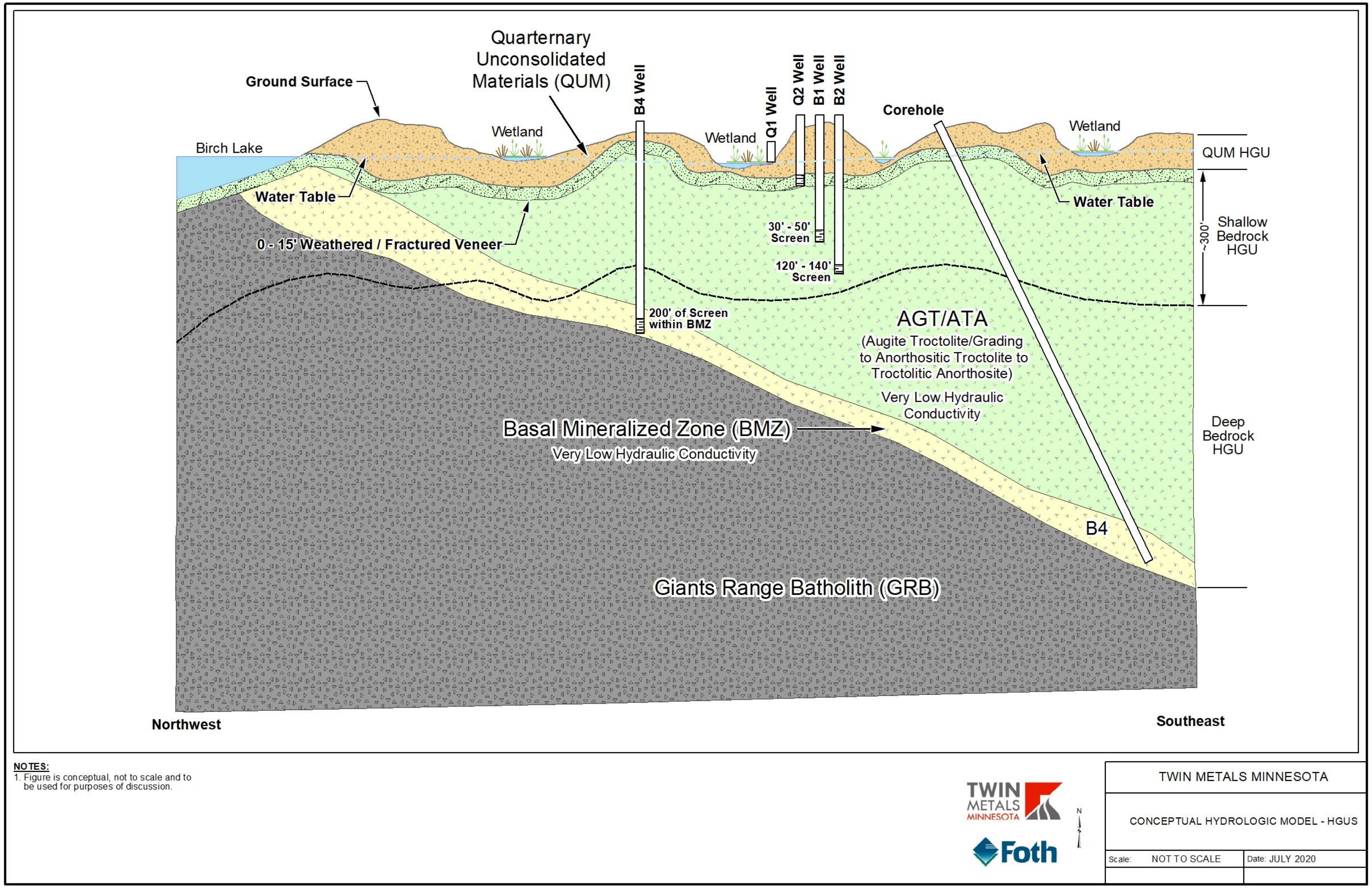


Figure 6-8 Conceptual Hydrology Model - HGUS

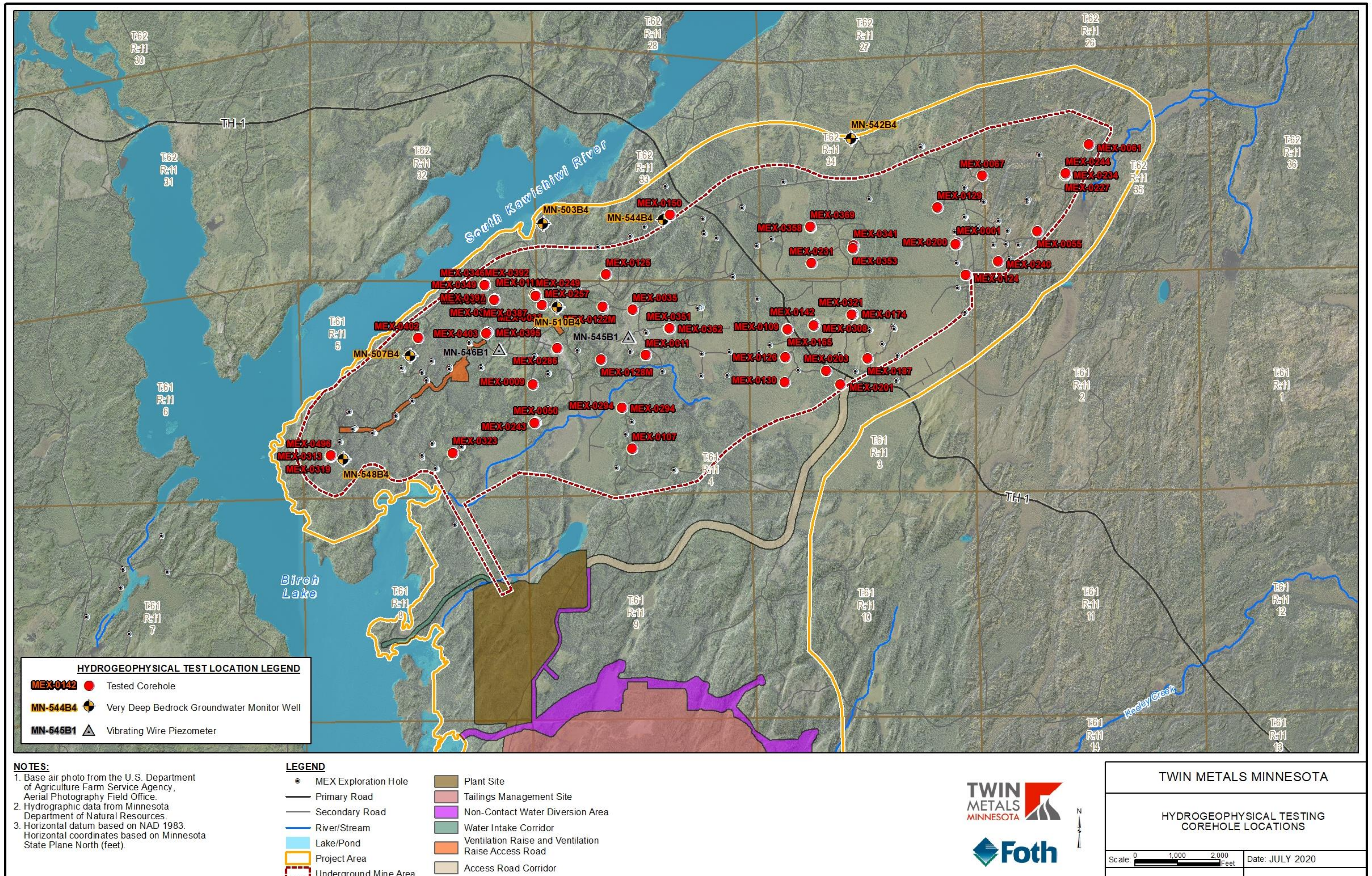
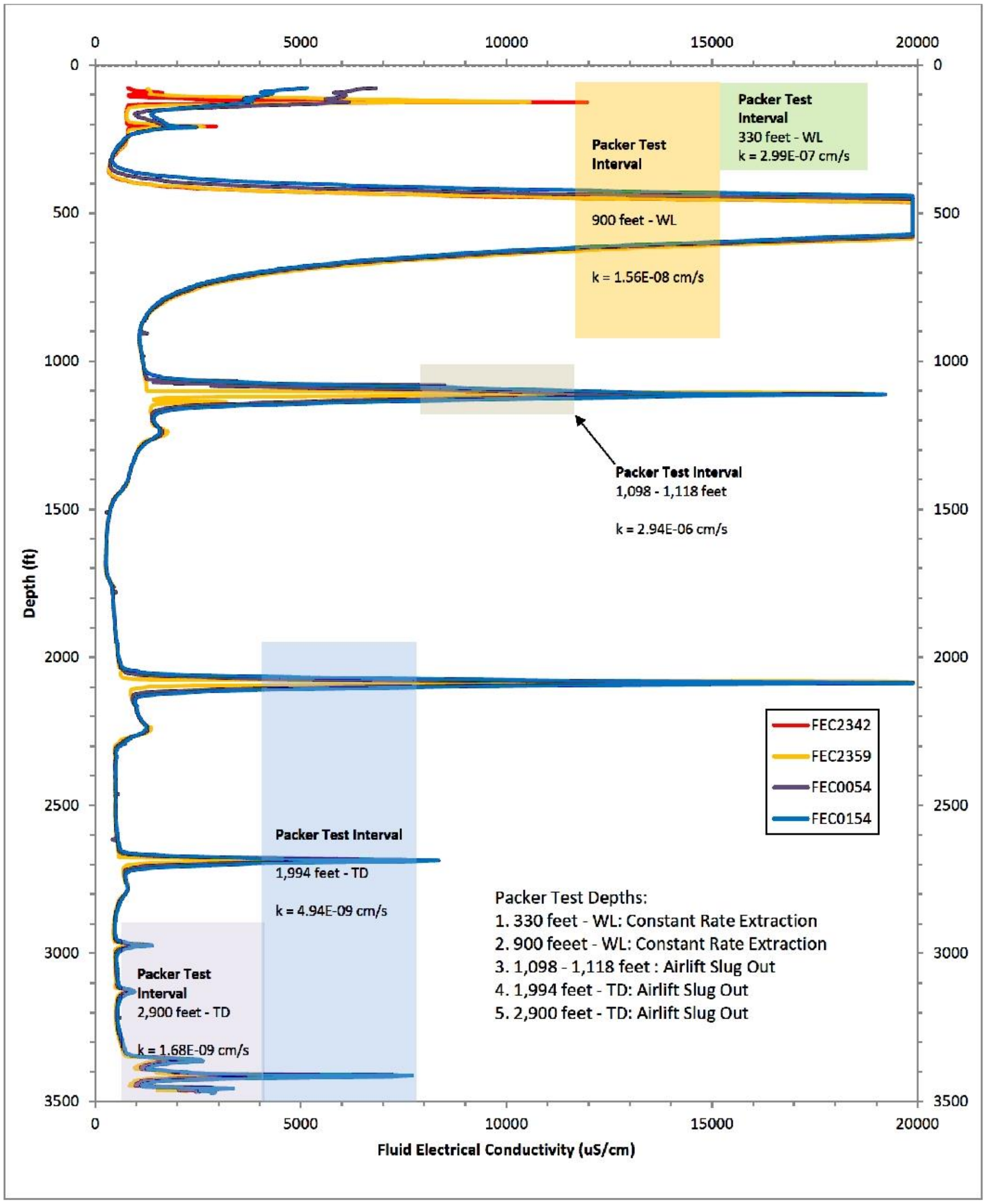


Figure 6-9 Hydrogeophysical Testing Corehole Locations



TWIN METALS MINNESOTA	
EXAMPLE HYDROPHYSICAL LOG	
Scale: AS SHOWN	Date: JULY 2020

Figure 6-10 Example Hydrophysical Log

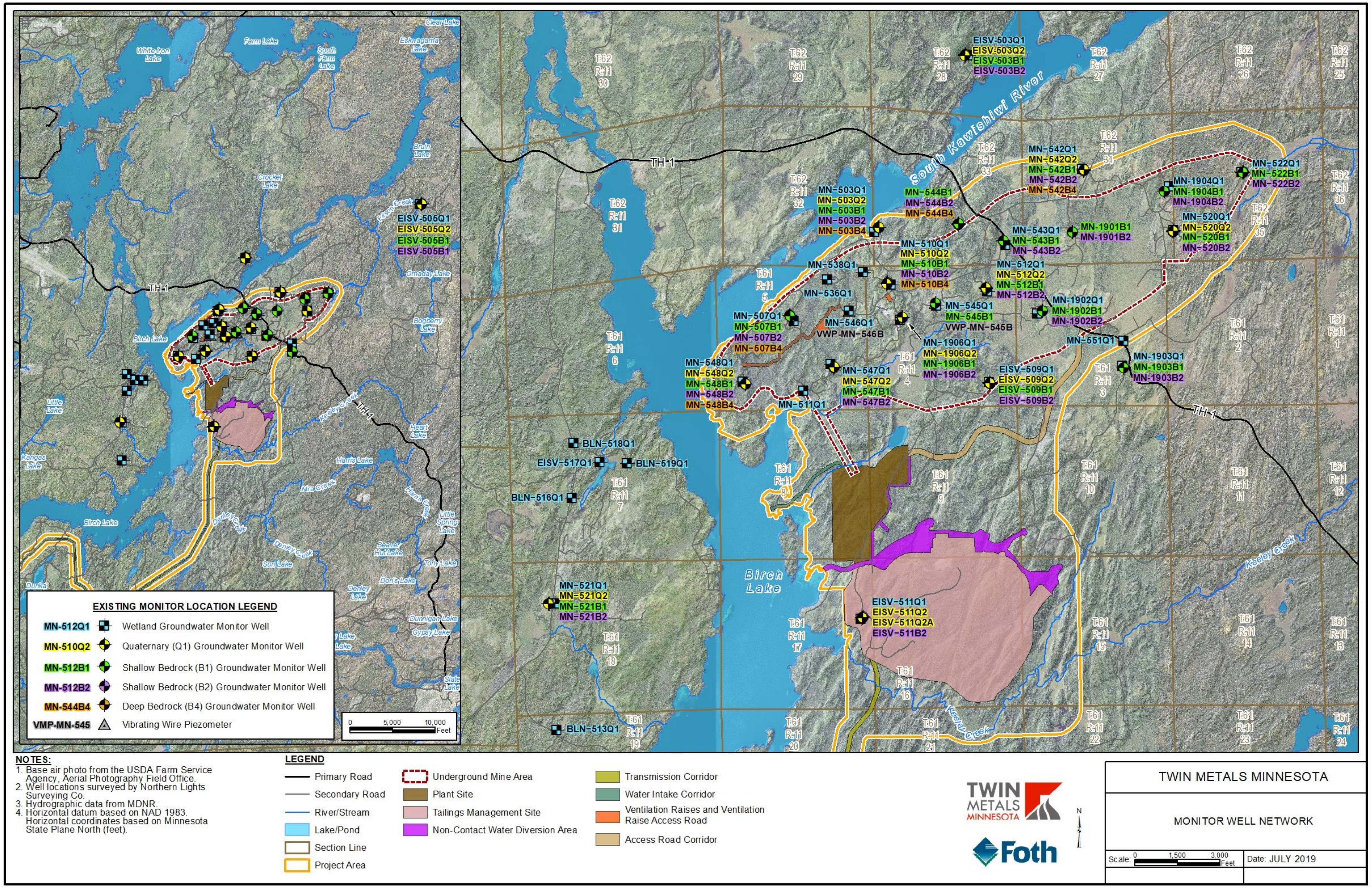


Figure 6-11 Monitor Well Network

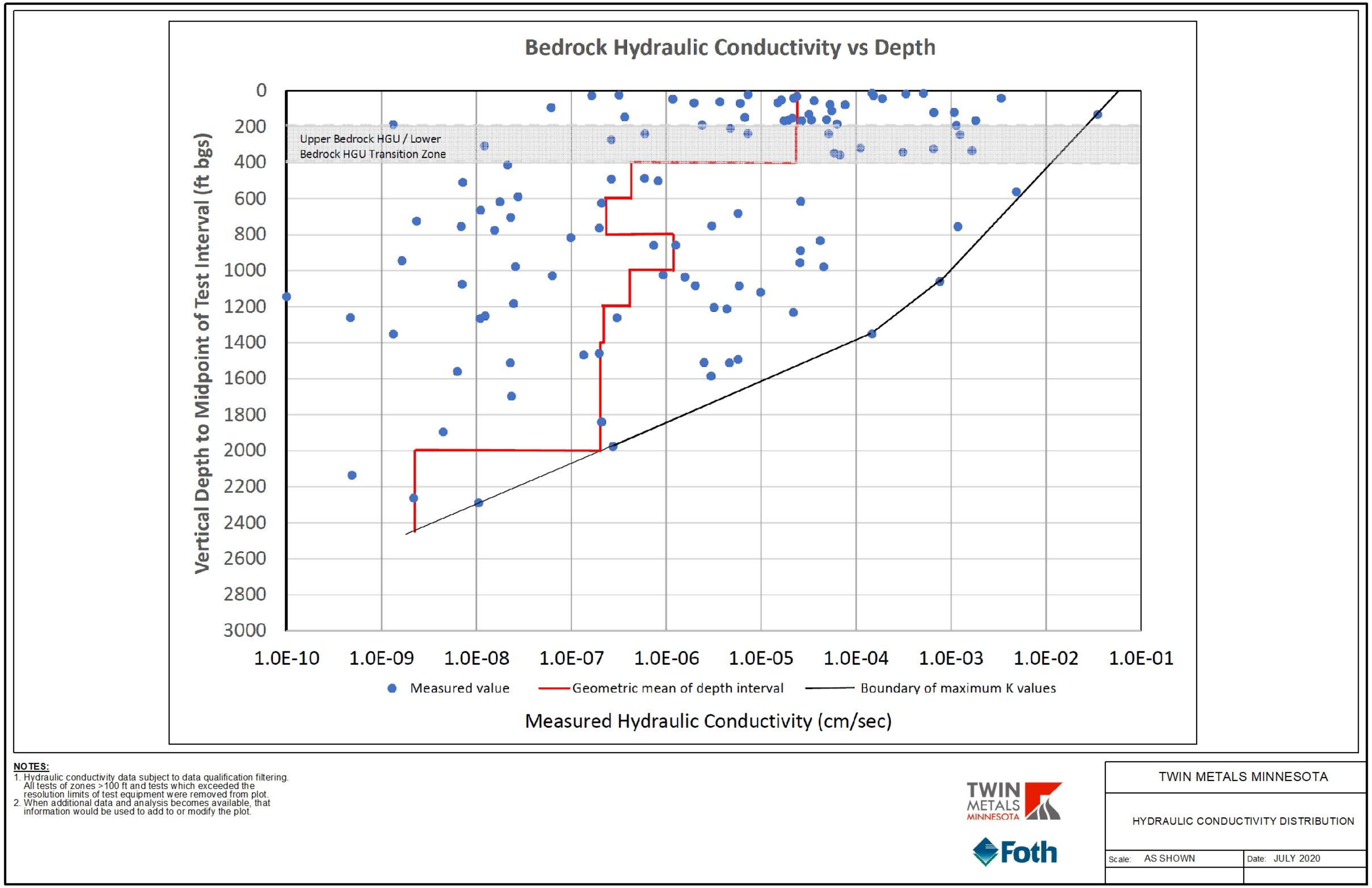


Figure 6-12 Hydraulic Conductivity Distribution

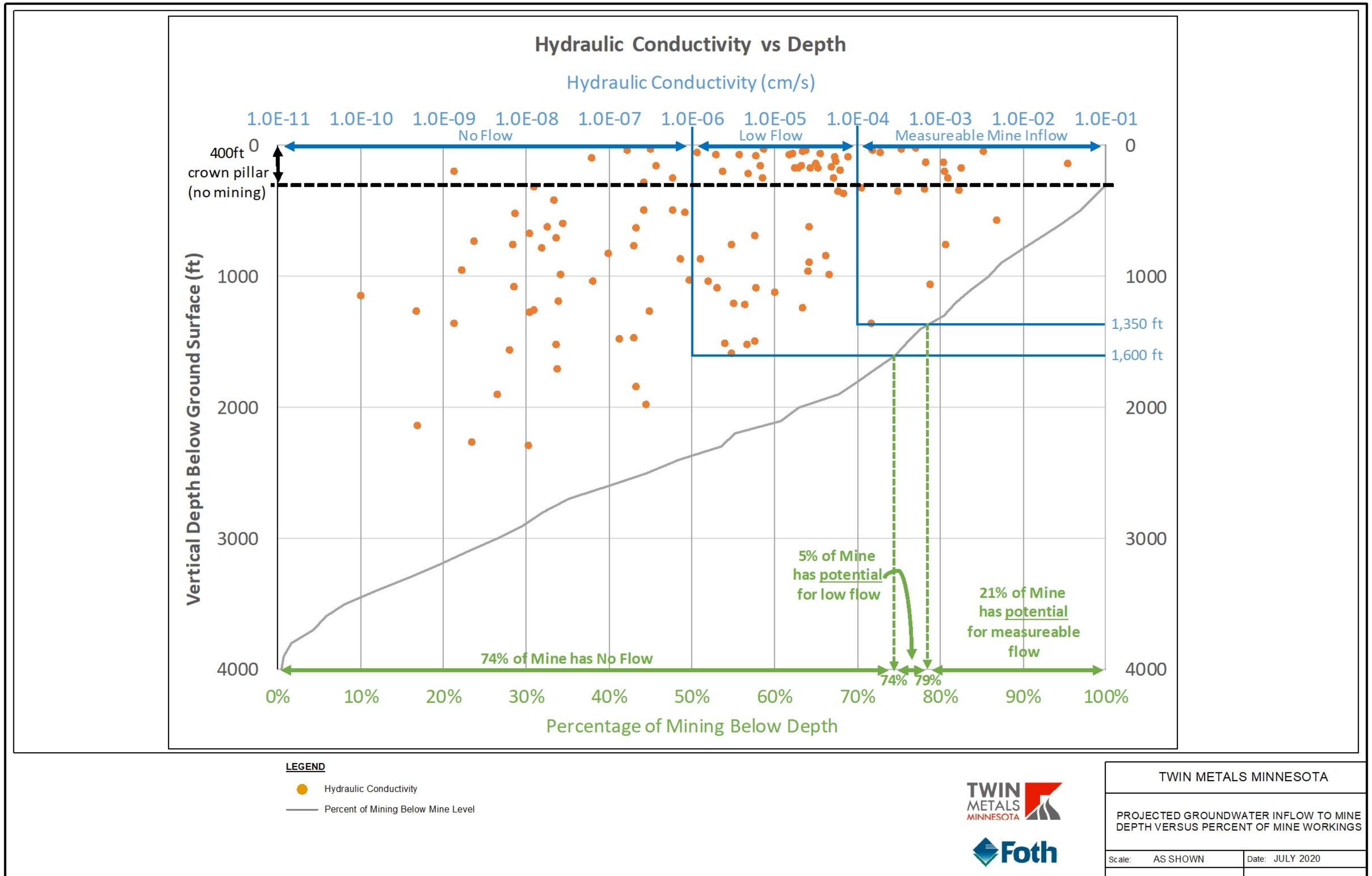


Figure 6-13 Projected Groundwater Inflow to Mine Water Depth Versus Percent of Mine Workings

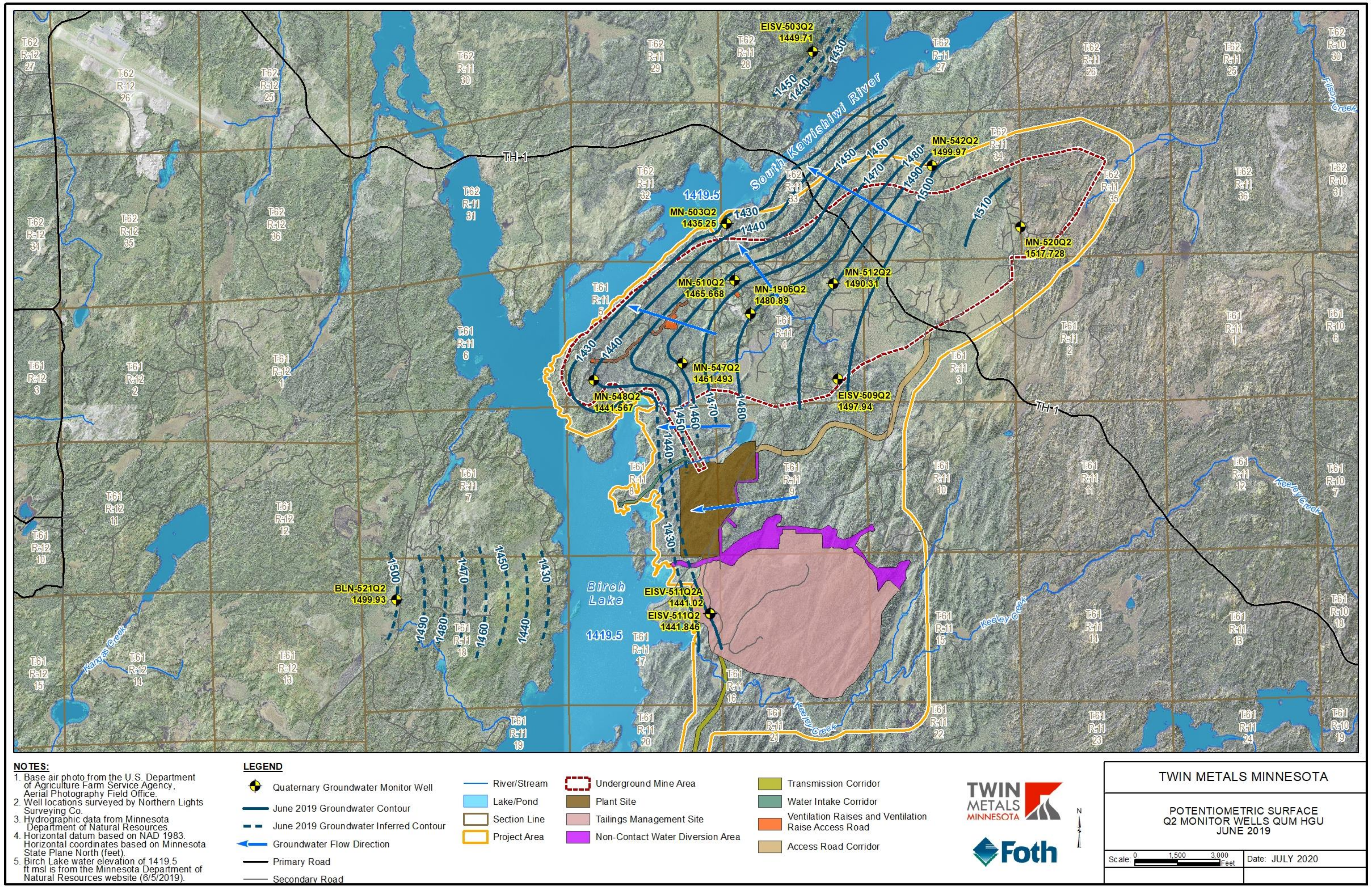


Figure 6-14 Potentiometric Surface Q2 Monitor Wells QUM HGU June 2019

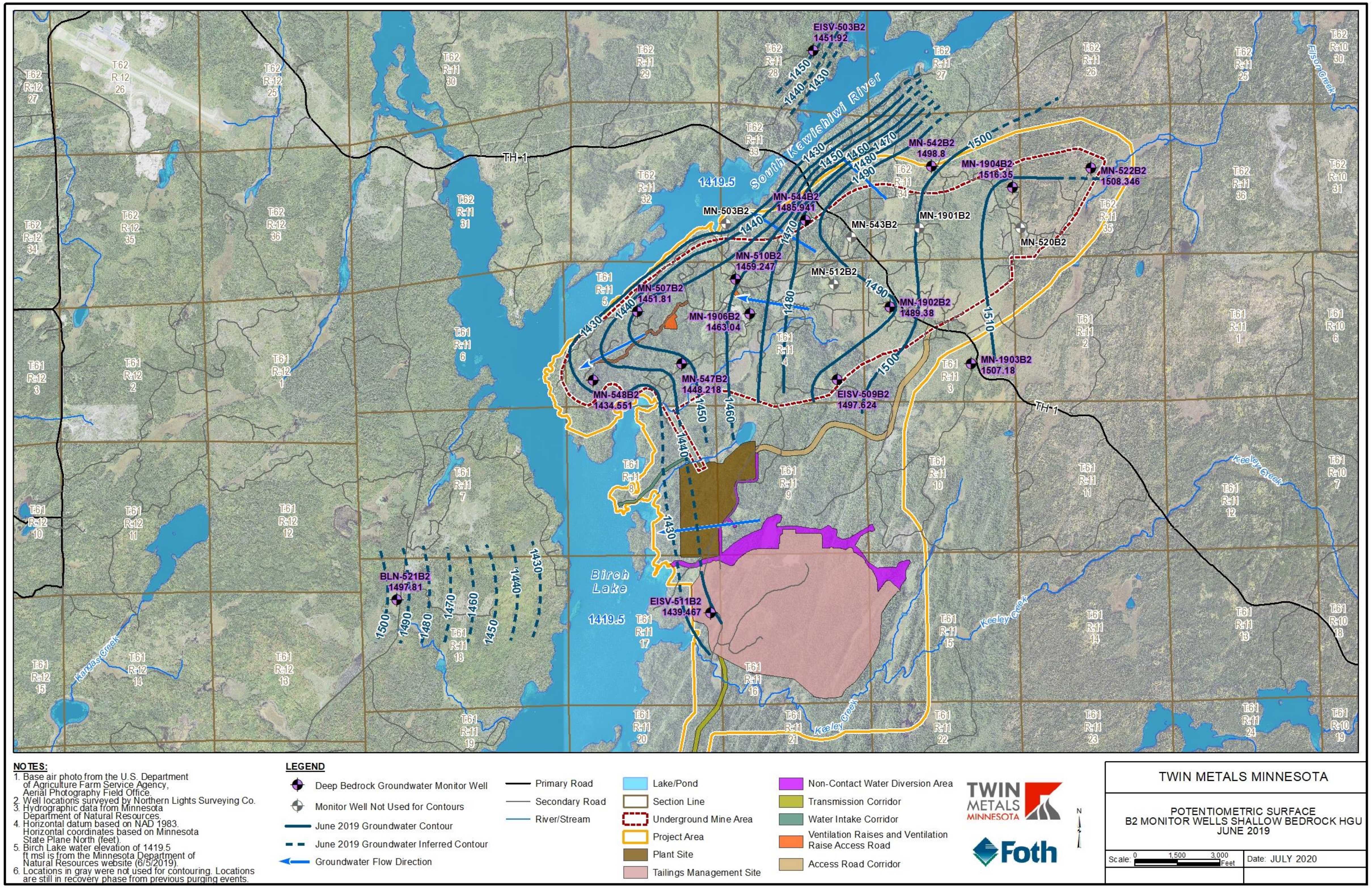


Figure 6-15 Potentiometric Surface B1 Monitor Wells Shallow Bedrock HGU June 2019

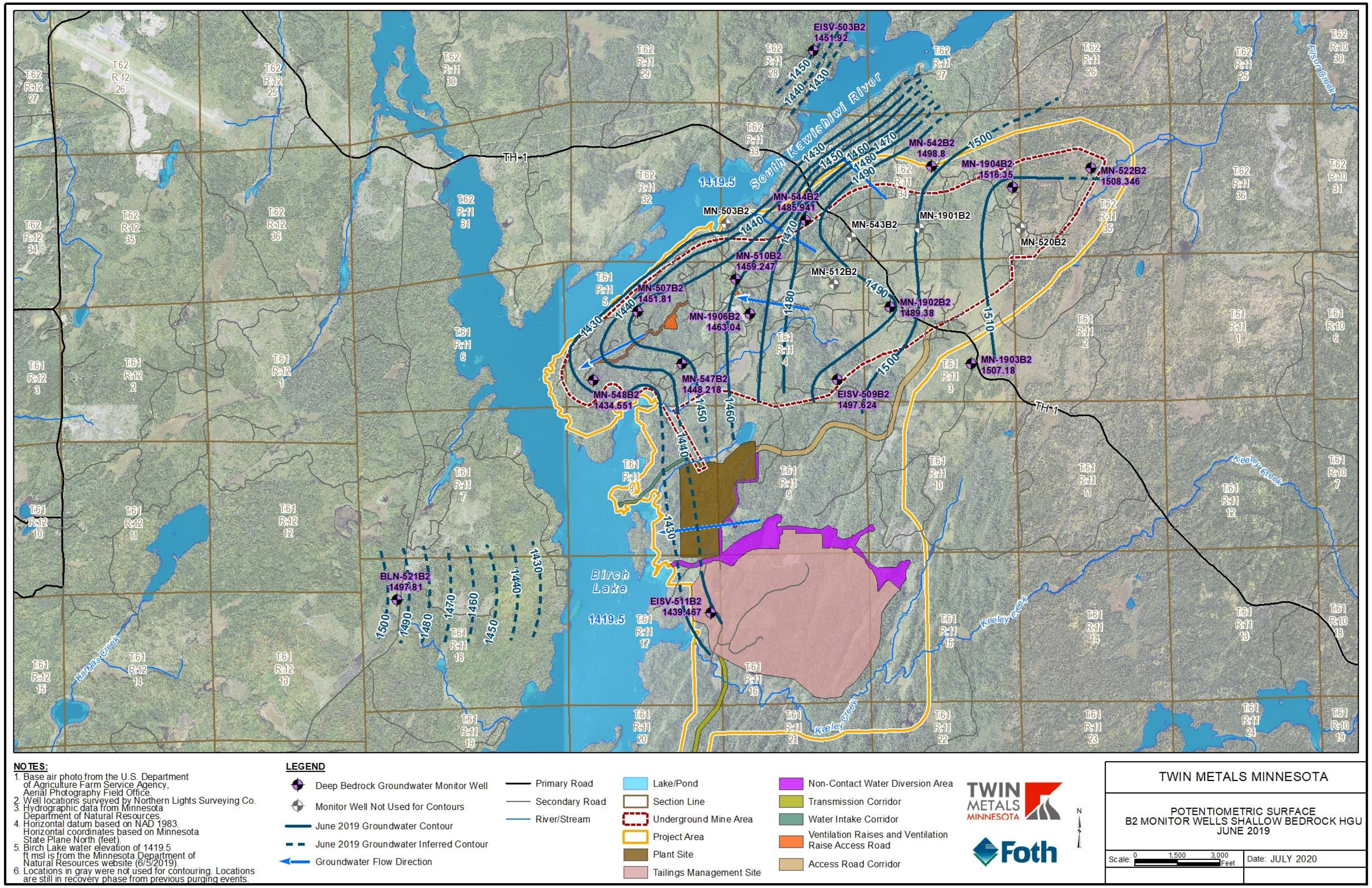


Figure 6-16 Potentiometric Surface B2 Monitor Wells Shallow Bedrock HGU June 2019

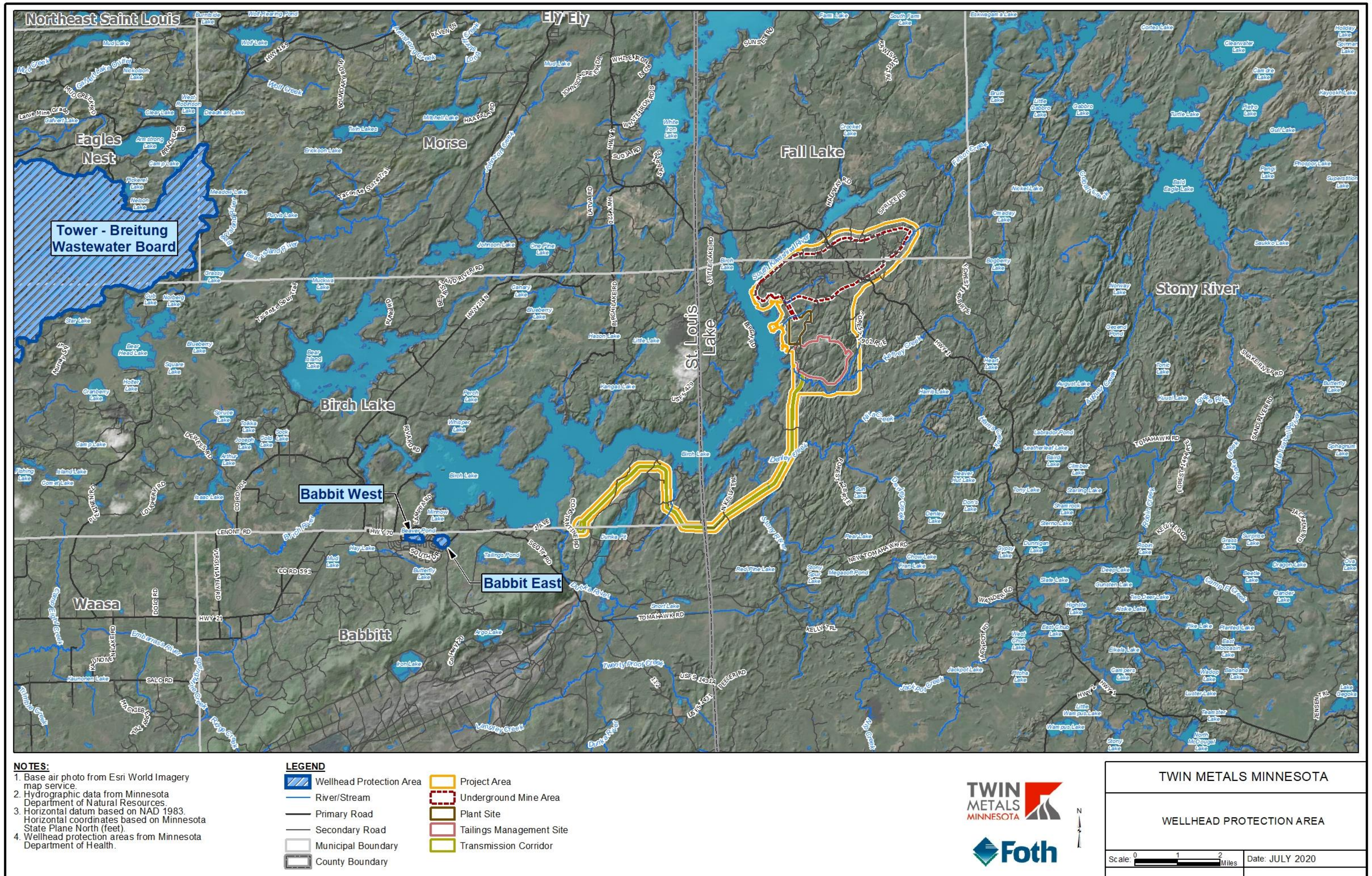


Figure 6-17 Wellhead Protection Areas

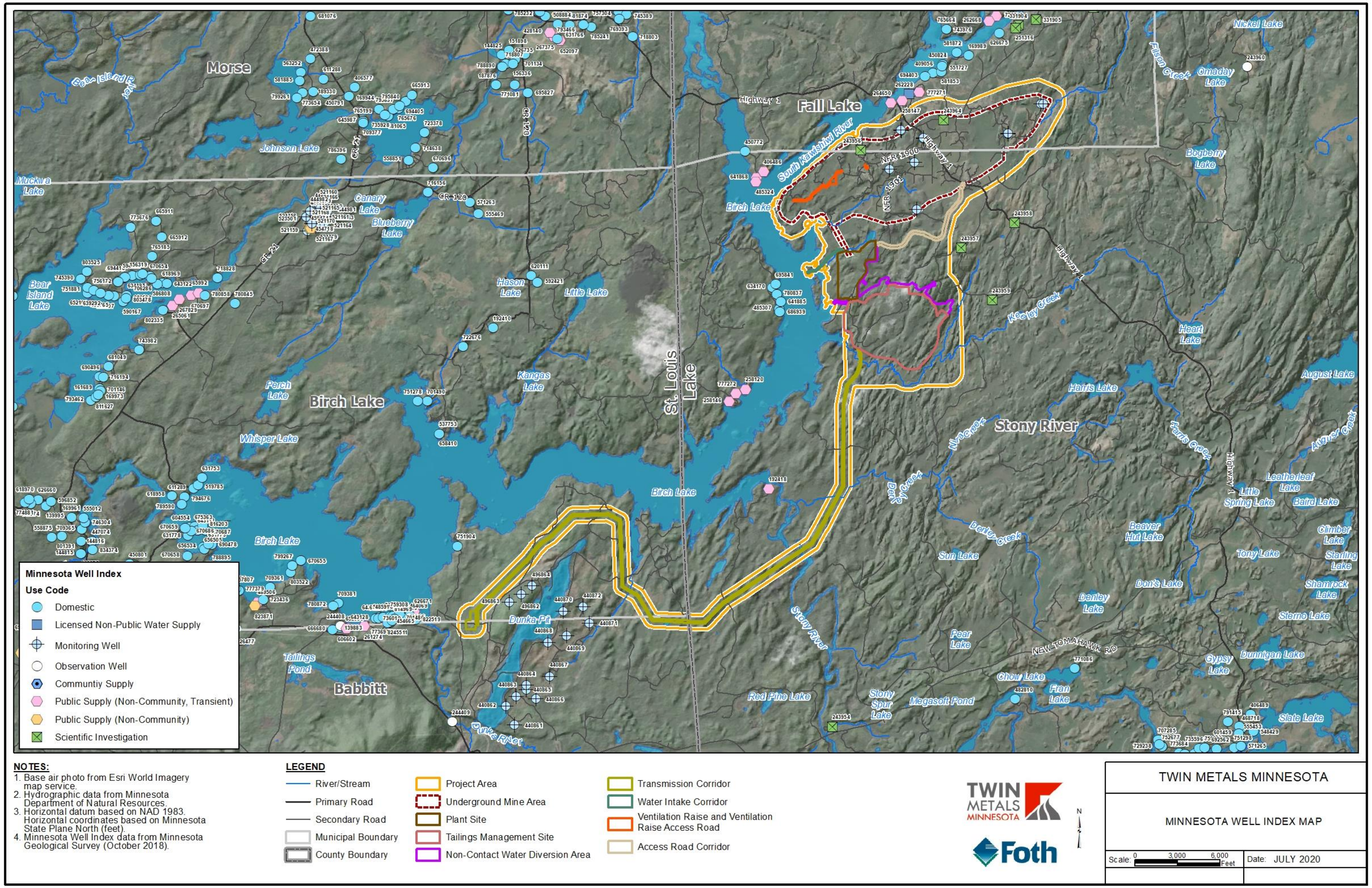


Figure 6-18 Minnesota Well Index Map

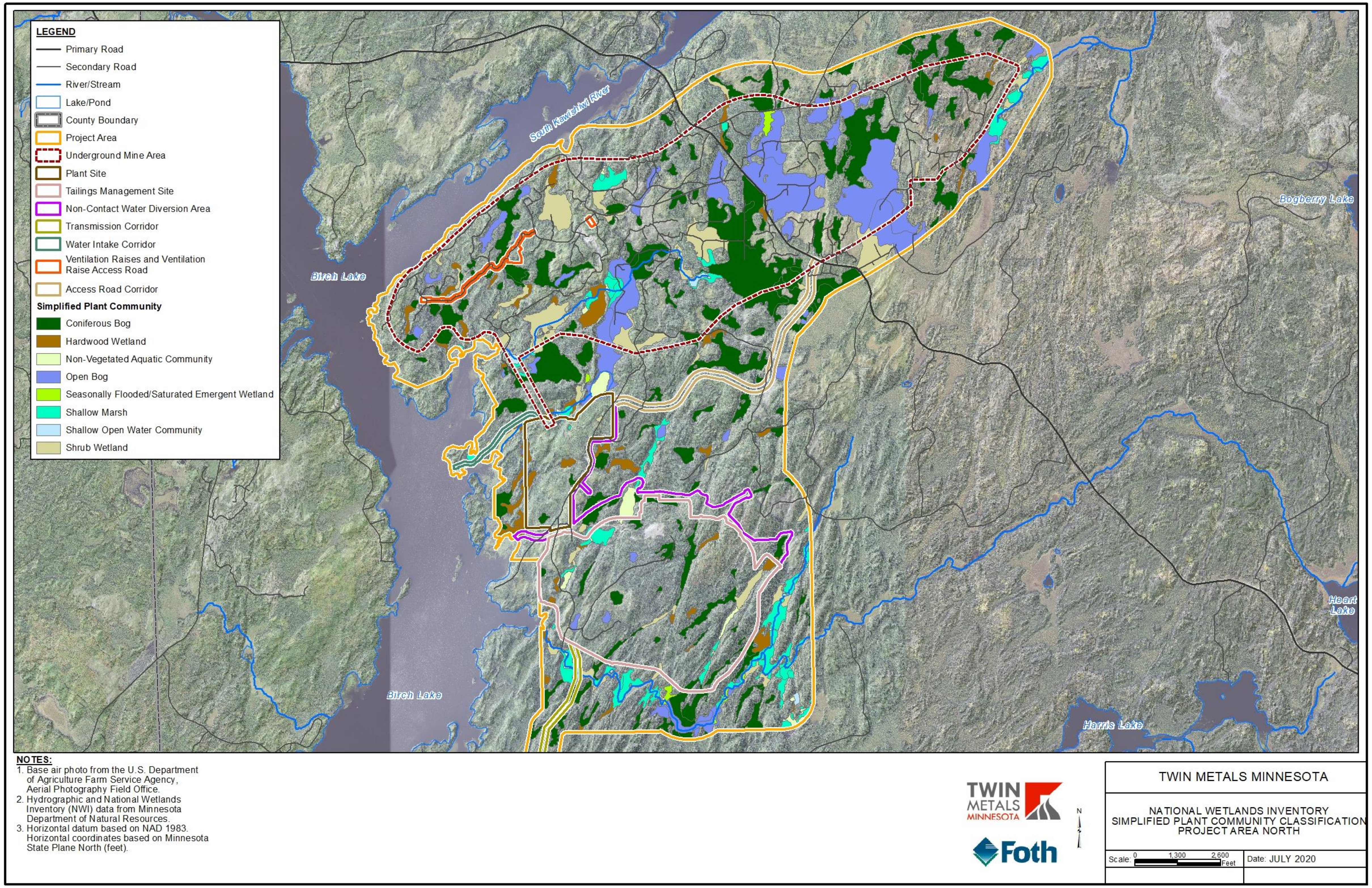
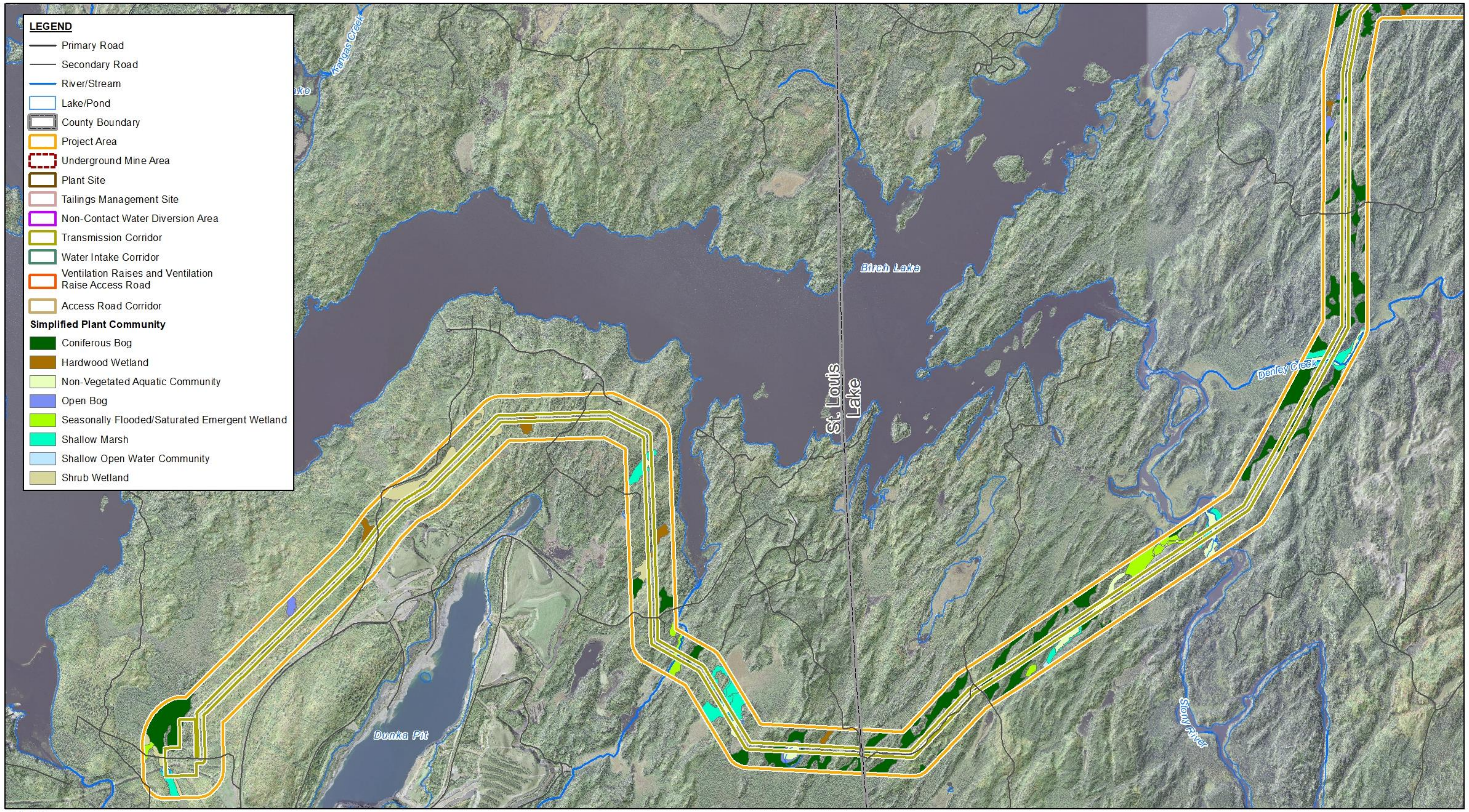


Figure 6-19 National Wetlands Inventory Simplified Plant Community Classification Project Area North



NOTES:
1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and National Wetlands Inventory (NWI) data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

TWIN METALS MINNESOTA

NATIONAL WETLANDS INVENTORY
SIMPLIFIED PLANT COMMUNITY CLASSIFICATION
TRANSMISSION CORRIDOR

Scale: 0 1,000 2,000 Feet | Date: JULY 2020

Figure 6-20 National Wetlands Inventory Simplified Plant Community Classification Transmission Corridor

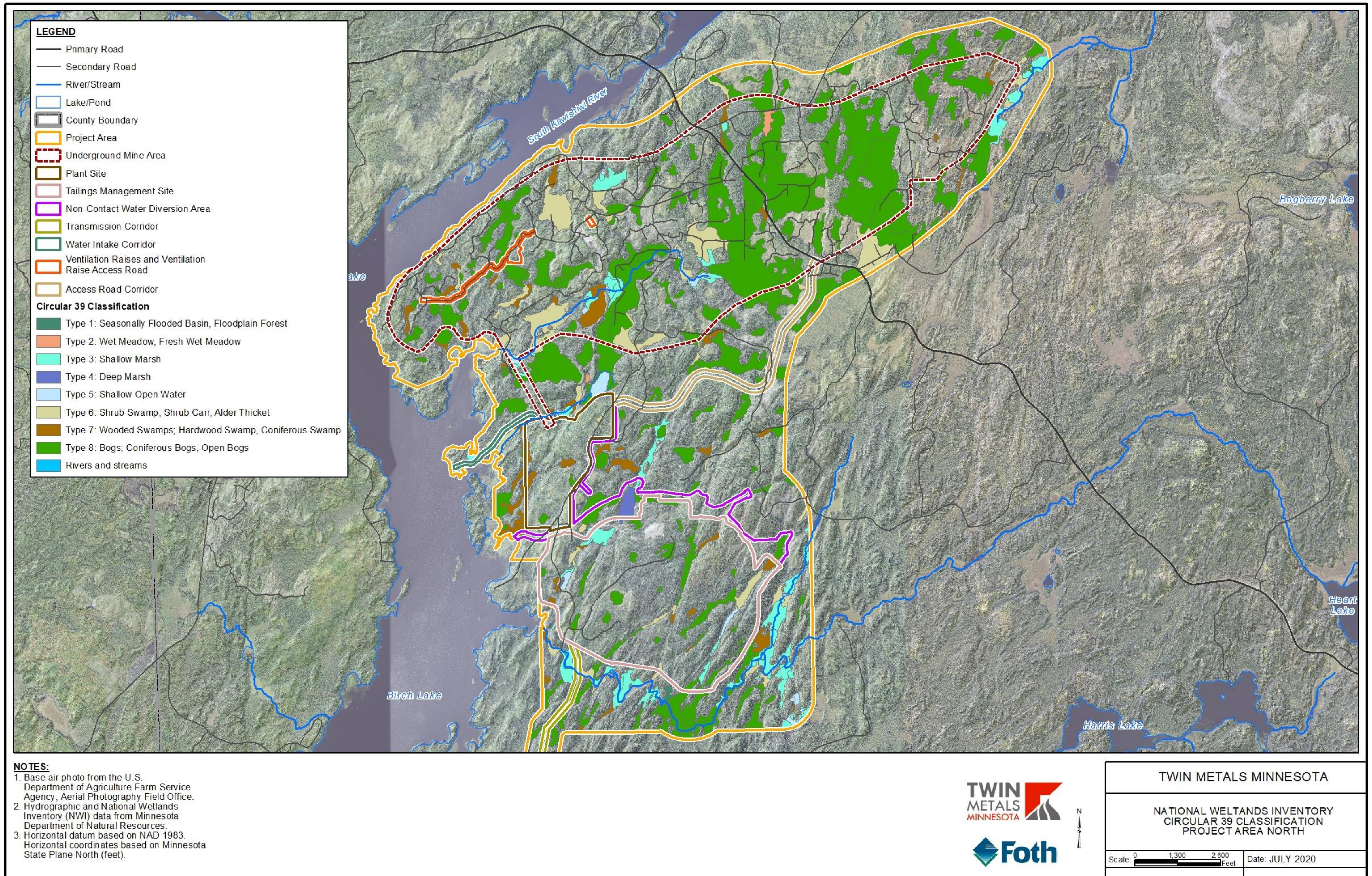


Figure 6-21 National Wetlands Inventory Circular 39 Classification Project Area North

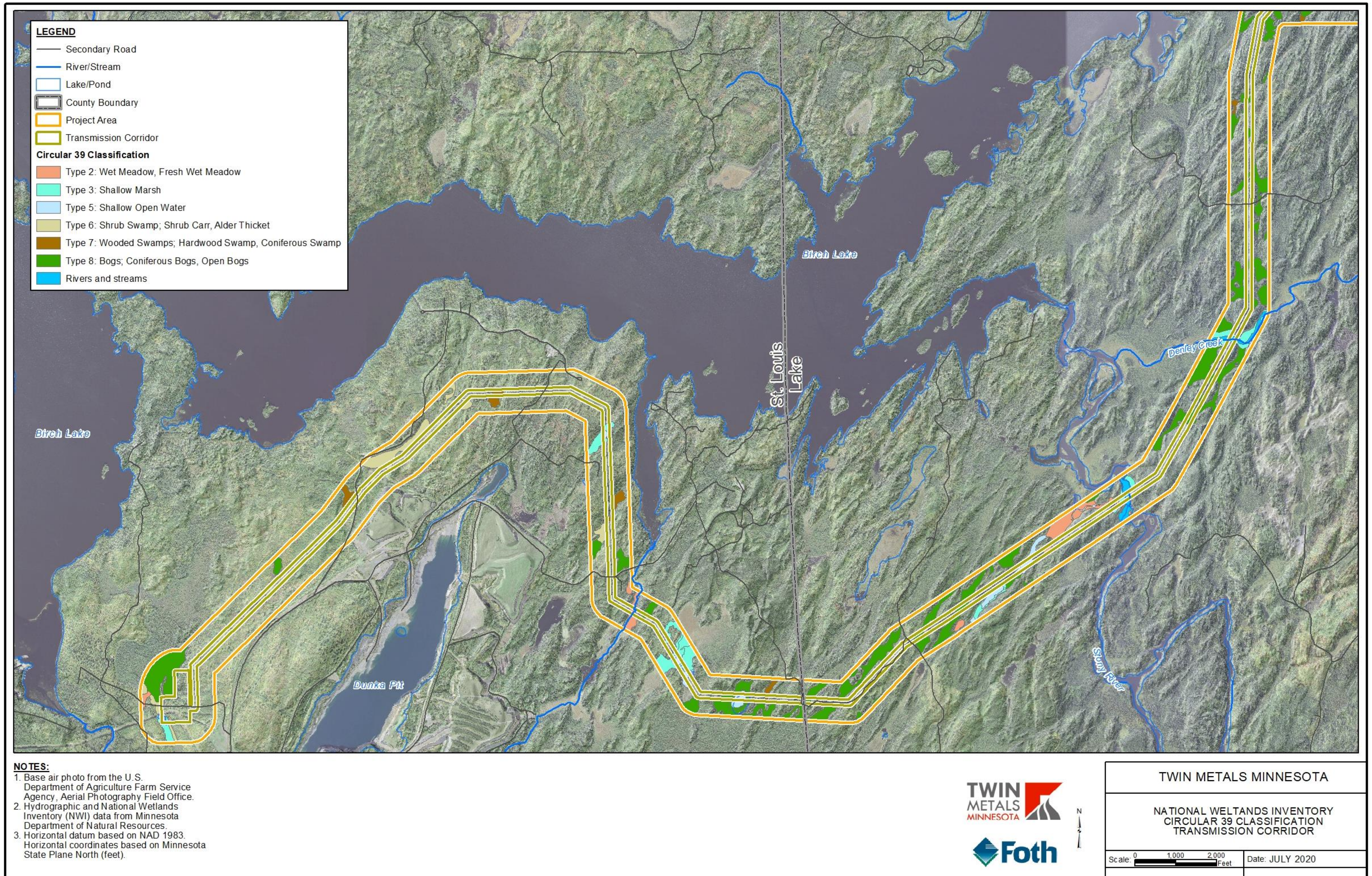


Figure 6-22 National Wetlands Inventory Circular 39 Classification Transmission Corridor

7.0 CONTAMINATION / HAZARDOUS MATERIALS / WASTES

Section 7.0 addresses hazardous material handling and waste management practices that would be employed by the Project. In order to facilitate common understanding of the terminology used in this section, the following definitions are provided.

Solid Waste - According to the Resource Conservation and Recovery Act (RCRA) of Title 42 of the U.S. Code Chapter 82 § 6901 et seq, the term solid waste refers to "any garbage or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, resulting from industrial, commercial, mining, and agricultural operations, and from active communities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 1342 of title 33, or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended ." In addition, various federal and state regulatory programs have additional terms and approaches for addressing solid waste and the facilities associated with managing such waste.

Hazardous Materials - Hazardous materials are generally characterized as any materials that are potentially harmful to humans, animals, or the environment, by itself or through interaction with other substances or environmental settings. These materials may include, but are not limited to, items such as explosives, flammables, oxidizers, poisons, irritants, and corrosives. Hazardous materials are subject to federal requirements regarding the management, handling, and transportation of these materials, and regulated by the U.S. Environmental Protection Agency (USEPA), Occupational Safety and Health Administration, and U.S. Department of Transportation. Locally, Minnesota implements regulations for hazardous materials through the MPCA and Minnesota Department of Transportation (MnDOT).

Hazardous Waste - Hazardous wastes are defined by Minnesota as refuse, sludge, or other waste material or combinations of refuse, sludge, or other waste materials in solid, semi-solid, liquid, or contained gaseous form, which, because of the quantity, concentration, or chemical, physical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness. Like hazardous materials, hazardous wastes are subject to state and federal requirements regarding management, transportation, and disposal. Locally, Minnesota implements regulations for hazardous wastes through the MPCA and MnDOT.

7.1 Baseline Conditions

A review of the *What's In My Neighborhood* (MPCA, 2019) web mapping tool was conducted to identify potential areas of concern within or proximal (within 0.5 mile [0.8 km]) to the Project area. Areas of concern identified, but not limited to, hazardous waste generators, solid waste facilities, remediation sites, leak sites, and locations with aboveground storage tanks. The review indicated there are no known areas of concern within the Project area; however, there are two potential areas of concern adjacent to the Project area identified as Sites 12 and 13 within Dunka Mine Area 8. Both locations are petroleum remediation leak sites associated with former LTV Steel mining activity located near the southwest end of the transmission corridor and the off-site substation. The MPCA identifies these sites as inactive and provided closure letters for both locations in 1998. No actions connected to the Project are anticipated to disturb these locations.

7.2 Project Impacts

7.2.1 Generation and Management of Solid Wastes

The Project would produce solid waste during construction, operation, and closure. Solid waste, as defined in the RCRA, would be disposed of in accordance with federal, state, and local regulations.

The following is a list of solid wastes anticipated to be generated by the Project, as well as the anticipated disposal method for each waste:

- Solid industrial waste – tires, scrap metal, concrete, construction waste, non-salvageable demolition debris, and office waste (paper, utensils, etc.). Solid industrial waste generated by the Project would be taken off-site to be treated by a third party and recycled when available.
- Unused blasting agents – expired or damaged containers of blasting caps, initiators and fuses, and other high explosives used in blasting. These items would be taken back by the explosives distributer or otherwise used concurrently during blasting activities.
- Spent equipment maintenance products -– solvent-contaminated fuels, grease, lubricants, anti-freeze, solvents, and lead-acid batteries used for equipment operation and maintenance. Spent equipment maintenance products would be recycled by a third-party vendor off-site.
- Waste oil – waste oil and lubricants would be collected and transported off-site by a buyer/contractor for recycling.
- Sewage – sewage would be removed and treated off-site by a third party.

7.2.2 Management of Hazardous Material

Hazardous materials stored on site would include diesel fuel, gasoline, propane, lubricants, coolant, lead acid batteries, concentration process reagents, explosives, and explosive devices. A preliminary list of fuel storage and consumption volumes is identified in Table 7-1, a preliminary list of anticipated reagents that would be used at the plant site and in the process is included in Table 7-2, and a preliminary list of emulsion that would be used is included in Table 7-3. A review of Safety Data Sheets would be conducted on final reagent selections and used to update Table 7-2 as applicable.

Table 7-1 Estimated Fuel Storage and Consumption

Fuel (L/yr)	Annual Consumption	Delivered Form	Storage (m^3)	Amount per Delivery	Anticipated Trucks per Month	Anticipated Consumption per Day (L)	Storage Time (days)
Diesel	20,700,000	Tanker	300	30,000 L / 25 ST	58	57,000	5
Gasoline	300,000	Tanker	20	20,000 L / 14.4 ST	2	500	24
Propane	12,700,000	Tanker	160	10 ST	53	35,000	5

Abbreviations:
L = liters
L/day = liters per day
L/yr = liters per year
m^3 = cubic meters
ST = short tons
t = tons

Table 7-2 Process Reagents

Reagent	Annual Consumption (ST)	Delivered Form	Storage (ST)	Amount per Delivery (ST)	Deliveries per year
TETA (triethylenetetramine)	650	Bulk - Solution	25	19.6	34
Sodium Sulphite (Na_2SO_3)	610	Bags	25	15.4	40
Aerophine 3418A (sodium-diisobutyl dithiophosphinate)	60	Bulk - Solution	20	20.0	3
SIPX (Sodium isopropyl xanthate)	1,400	Bags	25	15.4	91
MIBC (Methyl isobutyl carbinol)	800	Bulk - Solution	30	16.2	50
Lime	10,500	Bulk	140	15.4	680
Copper Sulphate ($CuSO_4$)	600	Bags	25	15.4	39
Sulfuric Acid	840	Bulk - Solution	32	20.0	42
Flocculant	123	Bags	5	15.4	8
Binder (Slag-Cement Mix)	34,000	Bulk	450	15.4	2210

Abbreviations:
m^3 = cubic meters
ST = short tons
t = metric tonnes
tpy = tonnes per year
tpd = tonnes per day

Table 7-3 Approximate Emulsion Quantities

Reagent	Annual Consumption	Delivered Form	Storage	Amount Per Delivery	Anticipated Trucks per month	Approximate Consumption per day
Emulsion (Titan® 7000)	5,500 short tons	Tanker	20 short tons in insulated silo	15 short tons	30	15 short tons

Aboveground tanks (including aboveground tanks in the underground mine) would be used to store diesel, gasoline, lubricants, reagents, and propane. Diesel fuel would be delivered by truckload to a surface bulk delivery tank. The bulk delivery tank would be used to service a surface diesel transfer tank and a surface fueling station. The surface diesel transfer tank would assist in transporting diesel fuel via gravity flow to tanks located at one of three underground fueling stations. A surface gasoline filling station would have its own independent tank.

Reagents listed in Table 7-2 would be stored on site in a covered facility in the MnDOT-approved containers in which they were delivered until they are required in the reagent makeup area.

Emulsion, primers, and initiation systems for blasting would be kept in approved magazines on the surface. An aboveground emulsion tank would be used to store bulk loads of emulsion delivered to the site by trucks. A special transportation truck would be used to take the emulsion required for a day's use from the tank to the underground location of the shot.

Propane for surface structure and underground mine temperature control would be stored on surface.

7.2.3 Generation and Management of Hazardous Waste

Generation of hazardous wastes would be limited to residual cleaning fluids, residual reagents, and cross-mixed reagents. The remainder of the hazardous materials listed in Section 7.2.2 are anticipated to be wholly consumed or recyclable. Recyclable materials include batteries and coolant, which would be transported and disposed of by third party vendors. In order to reduce the potential for incidental contact and spills, hazardous solid wastes would be stored on site in facilities that comply with the RCRA regulations prior to shipment. Hazardous waste would be transported in USDOT-approved containers to permitted hazardous waste treatment, storage, and disposal facilities. Additionally, the Project would employ common practices such as mixing dissimilar fluids for disposal, proper labeling, employee training, recycling, and practicing proper documentation of disposal protocols, to avoid potential adverse effects.

The primary impact associated with the use of hazardous materials or the generation of hazardous wastes would be the potential for release of these materials to the environment. To minimize the potential for release, the Project would include the following design principles and BMPs, where necessary:

- Double walled storage tanks / piping;
- Properly sized containment areas;
- Vapor minimization;
- Indoor storage when practicable;
- Sight gauges;
- Scheduled inspections of storage tanks and piping;
- Proper training for handling, transfer, and storage of hazardous materials; and
- Proper maintenance programs for equipment.

Additionally, the Project would employ the following practices aimed at minimizing impact were a spill to occur:

- Maintain readily accessible spill response kits;
- Proper response training for employees;
- Overfill protection alerts;
- Grading of the plant site to facilitate containment; and
- Maintain and implement a Spill Contingency Plan.

7.2.4 Contamination / Hazardous Materials / Wastes Impacts Summary

The available information is adequate to make a reasoned decision about the potential for, and significance of, environmental impacts due the Project's use, transportation, or disposal of solid wastes, hazardous materials, and hazardous wastes. Impacts due the Project's use, transportation, or disposal of solid wastes, hazardous materials, and hazardous wastes are characterized in the following manner:

- Temporary – Solid wastes, hazardous materials, and hazardous wastes would be present only during the life of the Project. Hazardous wastes would be stored, transferred, and disposed of in a RCRA compliant manner;
- Extent – The extent of impacts associated with solid wastes, hazardous materials, and hazardous wastes would be low as the Project design incorporates principles aimed to minimize the potential for impacts, and the Project would comply with applicable regulations and employ BMPs to avoid impacts; and
- Regulatory Oversight – Hazardous waste storage, transportation, and disposal would be subject to continual oversight by the MnDOT and the MPCA.

7.3 Future Scope

No future scope of work is proposed.

8.0 TERRESTRIAL AND AQUATIC RESOURCES

8.1 Baseline Conditions

Terrestrial and aquatic resource baseline conditions were examined within the Project area using multiple sources of information outlined in Section 8.1.1. The Project area is used for baseline characterization and provides the context for assessing potential Project impacts to terrestrial and aquatic resources discussed in Section 8.2. The specific resources examined in this section include land cover, habitat, ecosystems, fish, wildlife, and vegetation including sensitive species.

8.1.1 Baseline Data Sources and Evaluation Methods

The following public data sets represent the best available data for the Project area and were used to describe the baseline terrestrial and aquatic resource conditions within the Project area:

- Land Cover and Habitat
  - USGS Gap Analysis Program (GAP) / LANDFIRE (USGS, 2011b)
  - USGS NLCD (USGS, 2011a)
  - MDNR / USFS Ecological Classification System ([ECS] MDNR, 2019c)
  - MDNR Minnesota Biological Survey ([MBS] MDNR, 2019d and MDNR, 2019e)
- Vegetative, Terrestrial Wildlife, and Sensitive Species Baseline
  - MDNR Rare Species Guide (MDNR, 2019f)
  - Minnesota Natural Heritage Information System (NHIS) Database (MDNR, 2018)
  - USFS Regional Forester Sensitive Species ([RFSS] USFS, 2012)
  - USFWS Midwest Region Endangered Species (USFWS, 2018)
  - USFWS Information for Planning and Consultation ([IPaC] USFWS, 2019)
  - MDNR Wildlife Action Plan 2015-25 (MDNR, 2016)
- Aquatic Species Baseline
  - MPCA Environmental Data Access (MPCA, 1998, 2014a, 2014b, 2014c)
  - MPCA Rainy River-Headwaters Monitoring and Assessment Report (MPCA, 2017)
  - MDNR Fishes of Minnesota Mapper (MDNR, 2015b)
  - USFS Current Invasive Plants (USFS, 2019)
  - Minnesota Department of Agriculture (MDA) 2019 Noxious Weed List (MDA, 2019)

The evaluation was conducted using the native geospatial data files. Land cover was reviewed along with habitat information to identify the habitats present. The identified habitats were reviewed and compared to the habitats that support various sensitive species of interest and within their designated range.

For the review of sensitive species, the following search criteria were considered:

- Any species listed as an endangered or threatened species under the authority of the Endangered Species Act of 1973;
- USFWS Migratory Bird, any bird listed under Title 50 Code of Federal Regulations Part 10.13.3 and protected under Migratory Bird Treaty Act of 1918;
- Bald eagles, protected under the Bald and Golden Eagle Protection Act of 1940;
- Any species listed by the MDNR as "endangered" or "threatened" by the authority of Minnesota Statute, section 84.0895, listed under Minn. R., chapter 6134, and protected under Minn. R., chapter 6212;
- Minnesota species of special concern which are listed under Minn. R., chapter 6134, but are not protected under Minnesota Statute, section 84.0895 or Minn. R., chapter 6212;
- Species on the USFS RFSS list. The USFS is required by the National Forest Management Act to maintain viable populations of native and desired non-native vertebrate species in National Forests and considers sensitive species as "those plant and animal species identified by a Regional Forester for which population viability is a concern as evidenced by significant current or predicted downward trend in numbers or density" (USFS, 2012);
- Species listed by the National Forest Management Act as Management Indicator Species for the SNF. These species are "…plant and animal species, communities, or special habitats selected for their emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent" (USFS, 1991); and
- Species in Greatest Conservation Need (SGCN), defined in the Minnesota Wildlife Action Plan 2015-2025.

The MDNR Rare Species Guide was used to further refine the selected habitats and sensitive species for inclusion in the analysis. The habitats described by the MDNR Rare Species Guide are those commonly used by a species but are not inclusive of all the habitats that a species may use or be found in. The Border Lakes Subsection was used for this analysis, because the Project area would be almost entirely within this subsection. Less than 0.3% of the Project area would be located in the Nashwauk Upland Subsection on the southern margin of the Project area. The habitats identified in this analysis were: Forest Acid Peatland, Fire Dependent Forest, Mesic Hardwood Forest, Non-Forested Acid Peatland, and Non-Forested Rich Peatland for terrestrial species and Small Rivers and Streams, Littoral Zone of Lake, and Deep Water Zone of Lake for aquatic species. The search criteria are shown in Table 8-1 through Table 8-3.

Table 8-1 Search Criteria for Potential Sensitive Vegetative Species in the Border Lakes Subsection (212La)

Rare Species Group	Habitats	Listing status
Moss	Forest Acid Peatland	Federal endangered
Lichen	Fire Dependent Forest	Federal threatened
Moss	Mesic Hardwood Forest	Federal candidate
Vascular plant	Non-Forested Acid Peatland	State endangered

Table 8-2 Search Criteria for Potential Sensitive Terrestrial Species in the Border Lakes Subsection (212La)

Rare Species Group	Habitats	Listing status
Amphibian	Non-Forested Rich Peatland	State threatened
Insect	Non-Forested Rich Peatland	State special concern
Mammal	Non-Forested Rich Peatland	State delisted
Mussel	Non-Forested Rich Peatland	U.S. Forest Service sensitive
Reptile	Non-Forested Rich Peatland	U.S. Forest Service sensitive
Snail	Non-Forested Rich Peatland	U.S. Forest Service sensitive
Spider	Non-Forested Rich Peatland	U.S. Forest Service sensitive

Table 8-3 Search Criteria for Potential Sensitive Aquatic Species in the Border Lakes Subsection (212La)

Rare Species Group	Habitats	Listing status
Amphibian	Small Rivers and Streams	U.S. Forest Service sensitive
Fish	Littoral Zone of Lake	U.S. Forest Service sensitive
Fungus	Deep Water Zone of Lake	U.S. Forest Service sensitive
Insect	Deep Water Zone of Lake	U.S. Forest Service sensitive
Lichen	Deep Water Zone of Lake	U.S. Forest Service sensitive
Mammal	Deep Water Zone of Lake	U.S. Forest Service sensitive
Moss	Deep Water Zone of Lake	U.S. Forest Service sensitive
Mussel	Deep Water Zone of Lake	U.S. Forest Service sensitive
Reptile	Deep Water Zone of Lake	U.S. Forest Service sensitive
Snail	Deep Water Zone of Lake	U.S. Forest Service sensitive
Spider	Deep Water Zone of Lake	U.S. Forest Service sensitive
Vascular plant	Deep Water Zone of Lake	U.S. Forest Service sensitive

The NHIS Database was reviewed under license number LA-941 for any documented occurrences of endangered, threatened, special concern, and tracked species in the Project area. The NHIS Database was also reviewed for any occurrences of unique vegetation communities and animal assemblages in the Project area.

The USFWS IPaC and the USFWS Midwest Region Endangered Species lists were reviewed to identify additional species that may potentially be present and if there are designated critical habitats in the Project area.

The USFS GIS current invasive plants shapefile was reviewed to identify potential invasive and noxious weeds existing within the Project area. This database contains plant infestation polygons collected by the USFS in accordance with the National Invasive Plant Inventory Protocol. The species identified in this search were compared against the current MDA noxious weed list to determine if any occurrences exist within the Project area.

MDNR Section of Fisheries information and MPCA field observations data were reviewed as part of the aquatic resources baseline assessment.

8.1.2 Terrestrial Resources

The Project area is within the boundaries of the SNF and the Bear Island State Forest. Generally, the Project area is categorized as upland coniferous forest dominated by pine, fir, aspen, and spruce. Wet cover types within the Project area include lowland conifer swamps, poor fens, and bogs.

Human activities have influenced the characteristics of the existing terrestrial resources. Historically, much of the area was deforested in the late 1800s through the early 1900s (Reavie, 2013). Logging in the 19th century was followed by widespread slash-fueled wildfires in the 20th century. More recently fire suppression and vegetation management activities have determined the present forest makeup. Like most natural systems, the effects of disturbances on the landscape shape the habitats seen today.

The Project area is crossed by a system of unpaved roads that allow access for ongoing timber harvest, silvicultural activities, fire management, recreational access, and mineral exploration. On the northwestern edge of the Project area permanent residential structures have been constructed on the shore of Birch Lake.

The Project area has a history of mineral exploration and mining, as described in Section 4.0. Currently, Kasota Stone operates a stone quarry on state of Minnesota School Trust Lands located within the footprint of the tailings management site. Logging has also taken place on the School Trust Lands.

8.1.2.1 Terrestrial Habitat

In order to characterize the baseline habitat conditions for terrestrial species, existing land cover and habitats were identified based on the MDNR/USFS ECS, the USGS GAP data, and the USGS NLCD.

MDNR / USFS Ecological Classification System

The Project would be located almost entirely within the Ecological Classification System's Border Lakes subsection of the NSU section of the LMF Province, as shown on Figure 8-1. There is a small portion at the southern end of the Project area that is within the Nashwauk Uplands subsection.

The LMF is characterized by broad areas of conifer forest; mixed hardwood and conifer forests; and conifer bogs and swamps. The NSU section largely coincides with the extent of the Canadian Shield in Minnesota and consists mostly of fire-dependent forests and woodlands. At the Border Lakes subsection scale, the major forest communities are characterized as jack pine forest, white pine-red pine forest, and hardwood-conifer forest. The Nashwauk Uplands subsection is dominated by quaking aspen forests (MDNR, 2019a).

USGS Gap Analysis Program / LANDFIRE National Terrestrial Ecosystems Data

The Project area is also defined by the USGS GAP / LANDFIRE land cover types as predominantly upland coniferous as shown on Figure 8-2 and Figure 8-3. The Project area consists of:

- Boreal White Spruce-Fir-Hardwood Forest (42%);
- Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen (42%); and
- Boreal Jack Pine-Black Spruce Forest (8%).

The USGS GAP / LANDFIRE land cover types by Project components is provided in Table 8-4.

Table 8-4 U.S. Geological Survey GAP / LANDFIRE Project Area Data Baseline

GAP Classification	Baseline Acres
Boreal Aspen-Birch Forest	207.8
Boreal Jack Pine-Black Spruce Forest	503.6
Boreal White Spruce-Fir-Hardwood Forest	2625.6
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	2614.6
Cultivated Cropland	1.4
Developed, High Intensity	19.3
Developed, Low Intensity	1.3
Developed, Open Space	3.1
Eastern Boreal Floodplain	4.6
Harvested Forest - Grass/Forb Regeneration	3.3
Laurentian-Acadian Floodplain Systems	20.4
Laurentian-Acadian Northern Hardwoods Forest	26.8
Laurentian-Acadian Northern Pine-(Oak) Forest	115.9
Laurentian-Acadian Swamp Systems	55.6
Open Water (Fresh)	63.6
Quarries, Mines, Gravel Pits and Oil Wells	21.4
Total	6288.4

USGS National Land Cover Database

The NLCD data characterizes the Project area consists of:

- Woody Wetlands (39%),
- Evergreen Forest (32%),
- Mixed Forest (9%); and
- Shrub / Scrub Shrubland (8%) with minor amounts of other land covers including Grassland / Herbaceous and Deciduous Forest.

The NLCD land cover types are shown on Figure 8-4 and Figure 8-5 and are broken down by Project components in Table 8-5.

Table 8-5 National Land Cover Data Project Area Baseline

National Land Cover Data Classification	Baseline Acres
Deciduous Forest	283.1
Developed, Open Space	192.7
Developed, Low Intensity	0.4
Emergent Herbaceous Wetlands	78.2
Evergreen Forest	2025.9
Grassland/Herbaceous	145.4
Mixed Forest	568.8
Open Water	58.7
Shrub/Scrub	494.7
Woody Wetlands	2439.1
Total	6287.2

These different classifications are defined (USGS, 2011b) as:

- Woody Wetlands - areas where forest or shrubland vegetation accounts for >20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water;
- Evergreen Forest - areas dominated by trees generally >16.5 ft (5 m) tall, and >20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage;
- Mixed Forest - areas dominated by trees generally >16.5 ft (5 m) tall, and >20% of total vegetation cover. Neither deciduous nor evergreen species are >75% of total tree cover;
- Shrub / Scrub - areas dominated by shrubs; <16.5 ft (5 m) with shrub canopy typically >20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions;
- Grassland / Herbaceous - areas dominated by graminoid or herbaceous vegetation, generally >80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing; and

- Deciduous Forest - areas dominated by trees generally >16.5 ft (5 m) tall, and >20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.

MDNR Minnesota Biological Survey

The classification of baseline terrestrial resources within the Project area also considered the presence of native plant communities. A native plant community is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as pine forests, or marshes, that tend to repeat over space and time.

The MDNR MBS systematically collects, interprets, monitors, and delivers data on plant and animal distribution as well as the ecology of native plant communities and functional landscapes. Native plant communities are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes. For this review the MDNR Native Plant Community (NPC) database was used to identify whether native plant communities were present in the Project area. The database was developed by the MDNR using Minnesota's NPC Classification system.

The classification system hierarchy has six classification levels: system groups, ecological system, floristic region, NPC class, NPC type, and NPC subtype.

- System groups, the highest level, were created to allow development of manageable field keys for lower levels of the classification. System groups were formed by combining lower levels of the classification along major physiognomic and hydrologic splits in vegetation;
- Ecological systems, the next level are groups of NPCs unified by strong influence from a major ecological process or set of processes, especially nutrient cycling and natural disturbances;
- Floristic regions are divisions within ecological systems that reflect the distribution of Minnesota's plant species into characteristically northern, northwestern, central, and southern groups, or floras;
- NPC classes are units of vegetation that generally have uniform soil texture, soil moisture, soil nutrients, topography, and disturbance regimes. For wooded vegetation, NPC classes were developed by emphasizing understory vegetation more than canopy trees, under the hypothesis that in much of Minnesota understory plants are often more strongly tied to local habitat conditions (such as levels of nutrients and moisture) than are canopy trees;
- NPC types are defined by dominant canopy trees, variation in substrate, or fine-scale differences in environmental factors such as moisture or nutrients. Type distinctions were also made to describe geographic patterns within a class; and
- NPC subtypes are based on finer distinctions in canopy composition, substrates, or other environmental factors (MDNR, 2019d).

Within the Project area, the NPC data becomes less complete in coverage further down the hierarchy. At the ecological system level, the majority of the Project area has data available, and the ecological systems identified are shown on Figure 8-6 and Figure 8-7. Approximately 650 acres (263 ha) of the southwestern extent of the transmission corridor are unmapped (MDNR, 2019e). Within the Project area, the majority (93%) of the mapped ecological systems are acid peatland systems, fire-dependent forest / woodland systems, and a mesic forest complex, as shown in Table 8-6. Overall, upland communities cover approximately 70% of the Project area with wetland community types at 30% of the Project area.

Table 8-6 Minnesota Department of Natural Resources Minnesota Biological Survey Data Baseline for the Project Area

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Baseline Acres[1]
APn81a	Poor Black Spruce Swamp	S5	437.8
APn81b	Poor Tamarack - Black Spruce Swamp	S4	64.3
APn81b1	Poor Tamarack - Black Spruce Swamp, Black Spruce Subtype	S4	5.9
APn81b2	Poor Tamarack - Black Spruce Swamp, Tamarack Subtype	S4	88.1
APn91a	Low Shrub Poor Fen	S5	207.0
APn91b	Graminoid Poor Fen (Basin)	S3	4.1
Acid Peatland	*System Total*	*not applicable*	*807.3*
CTn32a	Mesic Mafic Cliff (Northern)	S3	2.0
Cliff/Talus	*System Total*	*not applicable*	*2.0*
BW_CX	Beaver Wetland Complex	No S-Rank	50.2
Beaver Wetland	*Complex Total*	*not applicable*	*50.2*
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex	No S-Rank	469.8
Mesic Woodland/Mesic Forest	*Complex Total*	*not applicable*	*469.8*
FDn32	Northern Poor Dry-Mesic Mixed Woodland	No S-Rank	248.3
FDn32a	Red Pine - White Pine Woodland (Canadian Shield)	S3	61.9
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	1048.8
FDn32c1	Black Spruce - Jack Pine Woodland, Jack Pine - Balsam Fir Subtype	S2	20.4
FDn33	Northern Dry-Mesic Mixed Woodland	No S-Rank	24.8
FDn33a	Red Pine - White Pine Woodland	S3	65.1
FDn43	Northern Mesic Mixed Forest	No S-Rank	4.0
FDn43a	White Pine - Red Pine Forest	S2	116.5
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	122.2
FDn43b2	Aspen - Birch Forest, Hardwood Subtype	S5	4.0
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*1715.9*
FPn62a	Rich Black Spruce Swamp (Basin)	S3	70.2
Forested Rich Peatland	*System Total*	*not applicable*	*70.2*
OPn81	Northern Shrub Shore Fen	No S-Rank	2.2

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Baseline Acres[1]
OPn81b	Leatherleaf - Sweet Gale Shore Fen	S5	27.8
OPn91	Northern Rich Fen (Water Track)	No S-Rank	4.8
Open Rich Peatland	*System Total*	*not applicable*	*34.9*
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	S4	20.7
WFn64c	Black Ash - Alder Swamp (Northern)	S4	8.2
Wet Forest	*System Total*	*not applicable*	*29.0*
WMn82b1	Sedge Meadow, Bluejoint Subtype	S5	41.4
Wet Meadow/Carr	*System Total*	*not applicable*	*41.4*
All Subtypes	**Project Area Biological Community**	**Total Acres**	**3220.7**

Notes:
[1] MBS NPC / candidate data is not available for the full Project area. Southwest portion of the transmission corridor has not been mapped.
Abbreviations:
MBS = Minnesota Biological Survey
NPC = Native Plant Community

The MBS data files include raw candidate data that has been mapped by MDNR's Ecological and Water Resources division but not certified for inclusion in the NPC database. Much of this candidate data shows disturbed features not part of the NPC classification and are tracked for future NPC mapping purposes. By definition these disturbed areas would not contain NPC. Table 8-7 and Table 8-8 summarize the candidate data associated by Project features. The candidate data from the NPC database shows that much of Project area has been disturbed with over 1,930 acres (781 ha) of disturbance. This includes almost all of the plant site and water intake corridor (143 acres [58 ha]), a portion of the tailings management site (151 acres [61 ha]) and much of the transmission corridor (199 acres [80.5 ha]).

Table 8-7 Previously Disturbed Project Area Land / Candidate Minnesota Biological Survey Data from Minnesota Department of Natural Resources

Project Feature	Acres[1]	Minnesota Department of Natural Resources Comments
Project area[2]	184.4	Upland and lowland native plant communities, nearly all harvested in mid to late 1960s or later. Regeneration to tree species typical of land forms here - jack pine, black spruce aspen. Overall native plant community conditions unknown.
Project area[2]	1932.2	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.
Project area[2]	199.1	Upland and lowland native plant communities nearly all harvested in early1970s or later. Regeneration to tree species typical of land forms here - jack pine and black spruce; planted red pine patches on state land in southwest. Overall native plant community conditions unknown.
Total	2315.7	Not applicable

Notes:
[1] Minnesota Biological Survey native plant community / candidate data is not available for the full Project area. Southwest portion of the transmission corridor has not been mapped.
[2] Three different polygons of candidate Minnesota Biological Survey data exist in the Project area. These are broken out to show the individual comments and associated acreages.

Table 8-8 Previously Disturbed Land / Candidate Minnesota Biological Survey Data by Project Feature from Minnesota Department of Natural Resources

Project Feature	Acres[1]	Minnesota Department of Natural Resources Comments
Plant site	148.8	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.
Tailings management site	177.6	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.
Access Road	11.0	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.
Transmission corridor[2]	2.4	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.
Transmission corridor[2]	30.6	Upland and lowland native plant communities nearly all harvested in early1970s or later. Regeneration to tree species typical of land forms here - jack pine and black spruce; planted red pine patches on state land in southwest. Overall native plant community conditions unknown.
Water intake corridor / facility	1.3	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.
Ventilation raise sites and access road	10.7	Upland harvests in mid to late 1970s or later. Regeneration mostly to aspen; some planted red pine and spruce. Overall native plant community conditions unknown. Fragmented by roads, mining exploration, and development.

Notes:
[1] Minnesota Biological Survey native plant community / candidate data is not available for the full Project area. Southwest portion of the transmission corridor has not been mapped.
[2] Two different polygons of candidate Minnesota Biological Survey data exist in the transmission corridor. These are broken out to show the individual comments and associated acreages.

The following are descriptions of the most prevalent ecological systems in the Project area:

- Acid Peatland Systems (MDNR, 2019g). – Acid peatland systems are characterized by conifer, low-shrub, or graminoid dominated communities that develop with Sphagnum in an acidic (pH < 5.5) environment. The types of flora associated with these systems are restricted to species adapted to these harsh, low-nutrient environments. Hydrology is dominated by precipitation rather than groundwater and the communities are widespread in the LMF province because of cool climate, abundant precipitation, numerous poorly drained basins, and extensive poorly drained glacial lake plains. The dominant vegetative species are those that can handle the difficult conditions, and are made up of dominantly tamarack, black spruce, bog laurel, labrador tea, small cranberry, pitcher plant, three-leaved false Solomon's seal, and tussock cottongrass;
- Fire Dependent Systems (MDNR, 2019h) – These are communities across the LMF province and are strongly influenced by wildfires. Fires have a strong impact on the mortality, germination, and regeneration of species within these

communities. These communities in the LMF province are characterized by evergreen species, most visibly pines and other conifers. Fire-dependent communities occur in areas with thin coarse sandy or gravelly soils over bedrock. Dominant species in these communities have adaptations for fire and include balsam fir, bunchberry, twinflower, ground-pine, white spruce, velvet-leaved blueberry, fly honeysuckle, and mountain maple; and

- Mesic Forest (MDNR, 2019i) - Poor Dry Mesic Woodland – In the Project area this consists of Northern Mesic Mixed Forest interspersed with Northern Poor Dry-Mesic Mixed Woodlands. The two NPC types are similar, and both commonly associated with bedrock outcrops and ridge complexes with relatively nutrient-poor, shallow, loamy soils. The community is more likely to occur on sites with higher quality soils such as valleys, lower slopes, and large depressions in the bedrock. Typical vegetative species in this type are balsam fir and paper birch in the tree canopy and sweet scented bedstraw, mountain maple, rose twistedstalk, and one-sided pyrola in the understory. The community occurs in rolling topography, along ridges or on ridge tops, where soils are thin, and boulders and / or bedrock are close to the surface. Typical vegetative species in this type are red pine and northern red oak in the understory and creeping snowberry, stemless lady's slipper, and tessellated rattlesnake plantain in the ground layer.

NPC types and subtypes are assigned conservation status ranks (MDNR, 2009) that reflect the risk of elimination of the community from within Minnesota. The scale is:

- S1 = critically imperiled
- S2 = imperiled
- S3 = vulnerable to extirpation
- S4 = apparently secure; uncommon but not rare
- S5 = secure, common, widespread, and abundant

Table 8-7 and Table 8-8 provide the S ranking for all the community and subtypes identified within the Project area. No S1 rankings are present within the Project area. S2 and S3 rankings are often combined and the total acreage within this ranking is 1,389 acres (562 ha). Acreage for S4 and S5 rankings respectively are 187.3 acres (75.8 ha) and 402.4 acres (162.8 ha).

8.1.2.2 *Vegetation*

Sensitive Species

There are 65 sensitive terrestrial vegetative species potentially present in the Project area (1 fungus, 14 lichen, 4 moss, and 46 vascular plants) as summarized in Table 8-9 through Table 8-12. The species' federal and state statuses, RFSS status, SGCN status, recorded occurrences within the Project area in the NHIS data, and listed habitats are also provided in Table 8-9 through Table 8-12. Descriptions for each of the species within the Project area are available from the MDNR Rare Species Guide (MDNR, 2019f).

The approximate locations of documented occurrences of sensitive vegetative and terrestrial species occurrences have been documented as shown on Figure 8-8.

Table 8-9 Terrestrial Fungus Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Sarcosoma globosum	A Cup Fungus	none	special concern	No	No	Fire Dependent Forest	Yes

Table 8-10 Terrestrial Lichen Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Ahtiana aurescens	Eastern candlewax lichen	none	special concern	No	Yes	Forested Rich Peatland	Yes
Allocetraria oakesiana	Yellow ribbon lichen	none	Threatened	Yes	No	Fire Dependent Forest	Yes
Bryoria fuscescens	Pale-footed Horsehair Lichen	none	special concern	No	No	Fire Dependent Forest, Forested Rich Peatland, Non-Forested Acid Peatland	Yes
Lobaria scrobiculata	Textured lungwort	none	endangered	Yes	No	Forested Rich Peatland	Yes
Melanohalea subolivacea	Brown-eyed Camouflage Lichen	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Menegazzia terebrata	Port-hole Lichen	none	special concern	No	No	Forested Rich Peatland	Yes
Ochrolechia androgyna	Powdery Saucer Lichen	none	special concern	No	No	Fire Dependent Forest, Forested Rich Peatland	Yes
Peltigera venosa	Fan lichen	none	special concern	No	No	Fire Dependent Forest	Yes
Protopannaria pezizoides	Brown-gray Moss-shingle Lichen	none	threatened	Yes	No	Forested Rich Peatland	Yes
Pseudocyphellaria holarctica	Yellow specklebelly lichen	none	endangered	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Ramalina thrausta	Angel's Hair Lichen	none	special concern	No	No	Forested Rich Peatland	Yes
Sticta fuliginosa	Peppered moon lichen	none	special concern	Yes	No	Forested Rich Peatland	Yes
Thelocarpon epibolum	A Species of Thelocarpon Lichen	none	special concern	No	No	Fire Dependent Forest, Forested Rich Peatland	Yes
Usnea longissima	Methuselah's Beard Lichen	none	special concern	No	No	Fire Dependent Forest, Forest Acid Peatland, Forested Rich Peatland	Yes

Table 8-11 Terrestrial Moss Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Buxbaumia aphylla	Bug-on-a-stick Moss	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest, Non-Forested Rich Peatland	Yes
Frullania selwyniana	Selwyn's Ear-leaf Liverwort	none	special concern	No	No	Forested Rich Peatland	Yes
Sphagnum compactum	Cushion Peat Moss	none	threatened	No	No	Fire Dependent Forest, Forest Acid Peatland	Yes
Splachnum rubrum	Red Parasol Moss	none	endangered	Yes	No	Forest Acid Peatland, Forested Rich Peatland, Non-Forested Acid Peatland	Yes

Table 8-12 Terrestrial Vascular Plants Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Achillea alpina	Siberian Yarrow	none	threatened	No	No	Fire Dependent Forest	Yes
Botrychium lunaria	Common Moonwort	none	threatened	Yes	Yes	Fire Dependent Forest	Yes
Botrychium minganense	Mingan Moonwort	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Botrychium mormo	Goblin Fern	none	threatened	Yes	No	Mesic Hardwood Forest	Yes
Botrychium oneidense	Blunt-lobed Grapefern	none	threatened	No	Yes	Mesic Hardwood Forest	Yes
Botrychium pallidum	Pale Moonwort	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Botrychium rugulosum	St. Lawrence Grapefern	none	special concern	No	Yes	Fire Dependent Forest	Yes
Botrychium simplex	Least Moonwort	none	special concern	No	No	Mesic Hardwood Forest	Yes
Botrychium spathulatum	Spatulate Moonwort	none	endangered	No	No	Fire Dependent Forest	Yes
Caltha natans	Floating Marsh Marigold	none	endangered	Yes	No	Non-Forested Rich Peatland	Yes
Cardamine pratensis	Cuckoo Flower	none	threatened	Yes	No	Forested Rich Peatland, Non-Forested Rich Peatland	Yes
Carex exilis	Coastal Sedge	none	special concern	No	No	Non-Forested Acid Peatland	Yes
Carex michauxiana	Michaux's Sedge	none	special concern	No	No	Forested Rich Peatland, Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes
Carex ormostachya	Necklace Sedge	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Cladium mariscoides	Twig Rush	none	special concern	No	No	Non-Forested Rich Peatland	Yes
Crataegus douglasii	Black Hawthorn	none	special concern	No	No	Fire Dependent Forest	Yes
Cypripedium arietinum	Ram's Head Orchid	none	threatened	Yes	No	Fire Dependent Forest, Forested Rich Peatland	Yes
Drosera anglica	English Sundew	none	special concern	No	No	Non-Forested Rich Peatland	Yes
Eleocharis flavescens var. olivacea	Olivaceous Spikerush	none	threatened	No	No	Non-Forested Acid Peatland	Yes
Eleocharis quinqueflora	Few-flowered Spikerush	none	special concern	No	No	Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes
Gymnocarpium robertianum	Northern Oak Fern	none	special concern	No	No	Forested Rich Peatland	Yes
Huperzia porophila	Rock Fir Moss	none	threatened	Yes	No	Mesic Hardwood Forest	Yes
Juncus stygius var. americanus	Bog Rush	none	special concern	No	No	Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes
Listera convallarioides	Broad-leaved Twayblade	none	special concern	No	No	Forested Rich Peatland	Yes
Luzula parviflora	Small-flowered Woodrush	none	threatened	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest, Forested Rich Peatland	Yes
Malaxis monophyllos var. brachypoda	White Adder's Mouth	none	special concern	No	No	Forested Rich Peatland	Yes
Malaxis paludosa	Bog Adder's Mouth	none	Endangered	No	No	Forested Rich Peatland	Yes
Moehringia macrophylla	Large-leaved Sandwort	none	Threatened	Yes	No	Fire Dependent Forest	Yes
Muhlenbergia uniflora	One-flowered Muhly	none	special concern	No	No	Non-Forested Acid Peatland	Yes
Osmorhiza berteroi	Chilean Sweet Cicely	none	endangered	Yes	No	Mesic Hardwood Forest	Yes
Osmorhiza depauperata	Blunt-fruited Sweet Cicely	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Phacelia franklinii	Franklin's Phacelia	none	threatened	No	Yes	Fire Dependent Forest	Yes
Piptatherum canadense	Canadian Ricegrass	none	threatened	Yes	No	Fire Dependent Forest	Yes
Platanthera clavellata	Small Green Wood Orchid	none	special concern	No	Yes	Forest Acid Peatland, Forested Rich Peatland	Yes
Polystichum braunii	Braun's Holly Fern	none	threatened	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Potamogeton confervoides	Algae-like Pondweed	none	endangered	Yes	No	Non-Forested Acid Peatland	Yes

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Prosartes trachycarpa	Rough-fruited Fairybells	none	endangered	Yes	No	Fire Dependent Forest	Yes
Pyrola minor	Small Shinleaf	none	special concern	No	No	Fire Dependent Forest, Forest Acid Peatland, Forested Rich Peatland	Yes
Ranunculus lapponicus	Lapland Buttercup	none	special concern	No	No	Forested Rich Peatland	Yes
Rubus chamaemorus	Cloudberry	none	threatened	Yes	No	Forest Acid Peatland	Yes
Rubus semisetosus	Swamp Blackberry	none	threatened	Yes	No	Forested Rich Peatland	Yes
Shepherdia canadensis	Soapberry	none	special concern	No	No	Fire Dependent Forest	Yes
Trichophorum clintonii	Clinton's Bulrush	none	threatened	No	No	Fire Dependent Forest	Yes
Utricularia geminiscapa	Hidden-fruit Bladderwort	none	threatened	Yes	No	Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes
Waldsteinia fragarioides var. fragarioides	Barren Strawberry	none	special concern	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Xyris montana	Montane Yellow-eyed Grass	none	special concern	No	Yes	Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes

Non-native Invasive Plants

There are 98 instances of non-native invasive plants potentially present in the Project. These include 16 instances of bull thistle (*Cirsium vulgare*), 33 instances of Canada thistle (*Cirsium arvense*), one instance of common St. John's wort (*Hypericum perforatum*), 43 instances of common tansy (*Tanacetum vulgare*), and five instances of spotted knapweed (*Centaurea biebersteinii*).

The MDA maintains a list of *State Prohibited* Noxious *Weeds*, with two categories; eradicate and control (MDA, 2019). Three species included on the MDA control list are also identified as present within the Project area (Canada thistle, common tansy, and spotted knapweed). There were no species identified in the Project area listed on the eradicate list.

8.1.2.3 Terrestrial Wildlife

Sensitive Species

There are 20 sensitive terrestrial wildlife species potentially present in the Project area (four insects, one spider, one reptile, six birds, and eight mammals). Potential sensitive terrestrial species within the Project area are identified in Table 8-13 through Table 8-17. These tables also includes species' federal and state listing status, RFSS status, SGCN status, SNF indicator species status, recorded occurrences within the Project area in the NHIS data, and listed habitats. Descriptions for each of the species within the Project area are not included but available from the MDNR Rare Species Guide (MDNR, 2019f).

Table 8-13 Terrestrial Bird Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area[1]	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Accipiter gentilis	Northern Goshawk	none	special concern	Yes	Yes	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Aegolius funereus	Boreal Owl	none	special concern	Yes	No	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest, Forested Rich Peatland	Yes
Haliaeetus leucocephalus	Bald Eagle	Eagle Act	delisted	No	Yes	No	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Cardellina Canadensis	Canada Warbler	Migratory Bird Act	none	No	No	No	No	not included in the MDNR rare species guide	Yes
Setophaga tigrina	Cape May Warbler	Migratory Bird Act	none	No	No	No	No	not included in the MDNR rare species guide	Yes
Coccothraustes vespertinus	Evening Grosbeak	Migratory Bird Act	none	No	No	No	No	not included in the MDNR rare species guide	Yes

Notes:
[1] The habitats described by the MDNR Rare Species Guide are those commonly used by a species but are not inclusive of all the habitats that a species may use or be found in.

Table 8-14 Terrestrial Insect Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area[1]	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Cicindela denikei	Laurentian Tiger Beetle	none	special concern	No	No	Yes	No	Fire Dependent Forest	Yes
Ophiogomphus anomalus	Extra-striped Snaketail	none	special concern	No	No	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Plebejus idas nabokovi	Nabokov's Blue	none	special concern	Yes	No	Yes	No	Fire Dependent Forest	Yes
Somatochlora forcipata	Forcipate Emerald	none	special concern	No	No	Yes	No	Forested Rich Peatland, Non-Forested Rich Peatland	Yes

Notes:
[1] The habitats described by the MDNR Rare Species Guide are those commonly used by a species but are not inclusive of all the habitats that a species may use or be found in.

Table 8-15 Terrestrial Mammal Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area[1]	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Canis lupus lycaon	Gray Wolf	threatened	delisted	No	Yes	No	No		Yes
Eptesicus fuscus	Big Brown Bat	none	special concern	No	No	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Lynx canadensis	Canada Lynx	threatened	special concern	No	No	Yes	No		Yes
Myotis lucifugus	Little Brown Myotis	none	special concern	Yes	No	Yes	Yes	Mesic Hardwood Forest	Yes
Myotis septentrionalis	Northern Long-eared Bat	threatened	special concern	No	No	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest	Yes
Alces alces	Moose	none	special concern	Yes	No	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest, Forested Acid Peatland, Forested Rich Peatland	Yes
Phenacomys ungava	Eastern Heather Vole	none	special concern	Yes	No	Yes	Yes	Fire Dependent Forest, Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes
Sorex palustris	American Water Shrew	none	none	No	No	No	No		
Napaeozapus insignis	Woodland Jumping Mouse	none	none	No	No	No	No		
Sorex fumeus	Smoky Shrew	none	special concern	No	No	Yes	No	Fire Dependent Forest, Mesic Hardwood Forest, Forest Acid Peatland, Forested Rich Peatland	Yes
Synaptomys borealis	Northern Bog Lemming	none	special concern	No	No	Yes	No	Forest Acid Peatland, Forested Rich Peatland, Non-Forested Rich Peatland, Non-Forested Acid Peatland	Yes

Notes:
[1] The habitats described by the MDNR Rare Species Guide are those commonly used by a species but are not inclusive of all the habitats that a species may use or be found in.
[2] The American water shrew and the woodland jumping mouse are included as "Species for which data were insufficient to determine if it met [Species of Greatest Conservation Need] criteria" in the 2015 - 2025 Minnesota State Wildlife Action Plan and are included in this table due to the unknown nature of their status in Minnesota. The American water shrew commonly inhabit hardwood swamps, mesic forests and around lakes and streams. The woodland jumping mouse commonly inhabit hardwood mesic habitats of coniferous forests and boreal swamps and also hardwood forests

Table 8-16 Terrestrial Reptile Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area[1]	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Emydoidea blandingii	Blanding's Turtle	none	threatened	No	No	Yes	No	Forested Rich Peatland	Yes

Notes:
[1] The habitats described by the MDNR Rare Species Guide are those commonly used by a species but are not inclusive of all the habitats that a species may use or be found in. The USFWS (USFWS, 2013) description characterizes the Blanding turtle as having a wide variety of habitats and preferring shallow, clear standing water with abundant aquatic vegetation. The species also requires sandy areas with grasses and shrubs for resting and due to their high mobility can occupy large areas often traversing inhabited or disturbed areas.

Table 8-17 Terrestrial Spider Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area[1]	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Habronattus calcaratus maddisoni	A Jumping Spider	none	special concern	No	No	No	No	Fire Dependent Forest	no[2]

Notes:
[1] The habitats described by the MDNR Rare Species Guide are those commonly used by a species but are not inclusive of all the habitats that a species may use or be found in.
[2] The only instance of the jumping spiders in Minnesota were at collection sites with cliffs capped by a layer of vegetation (MDNR, 2019d) which would not be present within the area of potential ground disturbance. Therefore, it is not expected that the Project would have an impact to the jumping spider.

8.1.3 Aquatic Resources

8.1.3.1 Aquatic Habitat

The Project area contains three different aquatic habitats: Small Rivers and Streams, Littoral Zone of Lake, and Deep Water Zone of Lake. Lowlands and wetlands are considered as part of and included in the terrestrial habitats.

8.1.3.2 Aquatic Biota

Fisheries survey data

The MPCA has conducted fisheries surveys on several streams and rivers in the Project area, as shown on Figure 8-9.

Birch Lake

Birch Lake is one of the most heavily used lakes in the MDNR's Tower Fisheries Management area. The MDNR has posted periodic fisheries survey data on the Birch Lake from 1981 through 2015. Fish species reported by the MDNR for Birch Lake include black crappie, bluegill, burbot, cisco species, largemouth bass, northern pike, rock bass, smallmouth bass, tullibee, walleye, yellow perch, white sucker, bluntnose minnow, common shiner, emerald shiner, golden shiner, Johnny darter, logperch, spottail shiner, and trout-perch.

The non-native invasive species rusty crayfish are noted in the MDNR's Lake Finder summary for Birch Lake, with surveys through 2012 showing the rusty crayfish to be limited to the east end of the lake. The rusty crayfish is of concern for disrupting ecosystems due to its greater destruction of submerged vegetation than native species, which negatively impacts fish habitat, particularly for sunfish

Keeley Creek

Keeley Creek is located just south of the tailings management site. In 2014, MPCA conducted a biological assessment of the creek at station ID 14RN006. MPCA documented the following fish species in the 2014 assessment: blacknose dace, brook stickleback, central mudminnow, common shiner, creek chub, finescale dace, genus notropis, Iowa darter, logperch, northern redbelly dace, pearl dace, and white sucker. Data on invertebrates was not collected. The assessment indicated that the fish rating was good with an Index of Biotic Integrity (IBI) of 88. The assessment also recorded August water temperature at 80.8°F (27.1°C) and dissolved oxygen levels of 7.07 mg/L (MPCA, 2014a).

Stony River

Stony River was sampled by the MPCA in 2014 upstream of where the transmission corridor would cross at station ID 14RN007. MPCA documented the following fish species in the 2014 assessment: burbot, mottled sculpin, tadpole madtom, Johnny darter, central mudminnow, rock bass, northern pike, and longnose dace. The assessment indicated that the fish and invertebrate rating was good, with an IBI of 87 and 72 respectively. The 2014 assessment also recorded August water temperature at 69.6°F (20.9°C) and dissolved oxygen levels of 9.89 mg/L (MPCA, 2014b).

Denley Creek

Denley Creek is a tributary to Stony River and is part of the Upper Stony River Watershed (MPCA, 2017). Denley Creek was sampled 0.5 mile upstream of where the transmission corridor would cross by the MPCA in 2014 at station ID 14RN067. MPCA documented the following fish species in the 2014 assessment: northern redbelly dace, blacknose dace, creek chub, blacknose shiner, common shiner, central mudminnow, white sucker, pearl dace, fathead minnow, finescale dace, and brook stickleback. In addition, MPCA documented a diverse invertebrate community including amphipods, balloon flies, beetles, black flies, broad-winged damselflies, chiggers, darners, epitheca, gastropods, hirudinea, large caddisflies, long-horn caddis, mayflies, micro-caddisflies, midges, net-spinning caddisflies, northern caddisflies, oligochaeta, and orconectes. The upstream portions of Denley Creek are designated as cold-water resources. Brook trout have been documented in upper portions of Denley Creek and associated tributaries. MPCA has concluded that Denley Creek fully supports the aquatic life use and that the fish and invertebrate rating was good, with an IBI of 75 and 83 respectively. The 2014 assessment also recorded August water temperature at 64.4°F (18.5°C) and dissolved oxygen levels of 5.59 mg/L.

Unnamed Creek

Unnamed Creek is located east of the Dunka Pit and is a tributary to Birch Lake. In 1998, MPCA conducted a biological assessment of the creek at station ID 98RN001. During that assessment, MPCA documented the following fish species: blacknose dace, brook stickleback, creek chub, finescale dace, northern redbelly dace, and pearl dace. Data on invertebrates was not collected. The assessment indicated that the fish rating was good, with an IBI of 64. The 1998 assessment also recorded July water temperature at 65.1°F (18.4°C) and dissolved oxygen levels of 6.9 mg/L (MPCA, 1998).

Sensitive Species

There are 16 aquatic sensitive species potentially present in the Project area (2 birds, 6 fish, 6 insects, 1 mussel, 1 reptile, and 16 vascular plants). Potential sensitive aquatic species within the Project area are identified in Table 8-18 through Table 8-23. These tables also includes species' federal and state status, RFSS status, SGCN status, recorded occurrences within the Project area in the NHIS data, and listed habitats. Descriptions for each of the species within the Project area are not included but available from the MDNR Rare Species Guide (MDNR, 2019f).

Table 8-18 Aquatic Sensitive Bird Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Disturbance
Cygnus buccinator	Trumpeter Swan	none	special concern	No	Yes	No	Littoral Zone of Lake	No
Sterna hirundo	Common Tern	none	threatened	No	Yes	No	Littoral Zone of Lake, Deep Water Zone of Lake	No

Table 8-19 Aquatic Sensitive Fish Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Disturbance
Acipenser fulvescens	Lake Sturgeon	none	special concern	Yes	Yes	No	Littoral Zone of Lake, Deep Water Zone of Lake	No
Coregonus nipigon	Nipigon Cisco	none	special concern	Yes	Yes	No	Deep Water Zone of Lake	No
Coregonus zenithicus	Shortjaw Cisco	none	special concern	Yes	Yes	No	Deep Water Zone of Lake	No
Couesius plumbeus	Lake Chub	none	special concern	No	Yes	No	Littoral Zone of Lake, Small Rivers and Streams	No
Ichthyomyzon fossor	Northern Brook Lamprey	none	special concern	Yes	Yes	No	Small Rivers and Streams	No
Lepomis peltastes	Northern Sunfish	none	special concern	No	Yes	No	Littoral Zone of Lake	No

Table 8-20 Aquatic Sensitive Insect Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Disturbance
Boyeria grafiana	Ocellated Darner	none	special concern	No	Yes	No	Small Rivers and Streams	No
Goera stylata	A Caddisfly	none	threatened	Yes	Yes	No	Small Rivers and Streams	No
Holocentropus glacialis	A Caddisfly	none	threatened	No	No	No	Littoral Zone of Lake	No
Ochrotrichia spinosa	A Purse Casemaker Caddisfly	none	endangered	No	Yes	No	Small Rivers and Streams	No
Ophiogomphus anomalus	Extra-striped Snaketail	none	special concern	No	Yes	No	Small Rivers and Streams	No
Triaenodes flavescens	A Triaenode Caddisfly	none	special concern	No	Yes	No	Small Rivers and Streams	No

Table 8-21 Aquatic Sensitive Mussel Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Disturbance
Lasmigona compressa	Creek Heelsplitter	none	special concern	Yes	Yes	No	Small Rivers and Streams	No

Table 8-22 Aquatic Sensitive Reptile Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Disturbance
Emydoidea blandingii	Blanding's Turtle	none	threatened	No	Yes	No	Small Rivers and Streams	Yes

Notes:
[1] See footnote 1 on Table 8-17 for additional habitat information on the Blanding's Turtle.

Table 8-23 Aquatic Sensitive Vascular Plant Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Disturbance
Callitriche heterophylla	Larger Water Starwort	none	threatened	Yes	No	No	Littoral Zone of Lake	No
Caltha natans	Floating Marsh Marigold	none	endangered	Yes	No	No	Small Rivers and Streams	No
Carex flava	Yellow Sedge	none	special concern	No	No	No	Small Rivers and Streams	No
Cladium mariscoides	Twig Rush	none	special concern	No	No	No	Littoral Zone of Lake	No
Crassula aquatica	Water Pygmyweed	none	threatened	No	No	No	Littoral Zone of Lake	No
Elatine triandra	Three-stamened Waterwort	none	special concern	No	No	No	Littoral Zone of Lake	No
Eleocharis robbinsii	Robbins' Spikerush	none	threatened	No	No	No	Littoral Zone of Lake	No
Juncus subtilis	Slender Rush	none	endangered	Yes	No	No	Littoral Zone of Lake	No
Littorella americana	American Shore Plantain	none	special concern	No	No	No	Littoral Zone of Lake	No
Myriophyllum heterophyllum	Broadleaf Water Milfoil	none	special concern	No	No	No	Littoral Zone of Lake	No
Najas gracillima	Slender Naiad	none	special concern	No	No	No	Littoral Zone of Lake	No
Nymphaea leibergii	Small White Waterlily	none	threatened	Yes	No	No	Littoral Zone of Lake, Small Rivers and Streams	No
Potamogeton oakesianus	Oakes' Pondweed	none	endangered	Yes	No	No	Littoral Zone of Lake	No
Subularia aquatica ssp. americana	Awlwort	none	threatened	Yes	No	No	Littoral Zone of Lake	No
Torreyochloa pallida	Torrey's Mannagrass	none	special concern	No	No	No	Littoral Zone of Lake, Small Rivers and Streams	No
Utricularia resupinata	Lavender Bladderwort	none	threatened	Yes	No	No	Littoral Zone of Lake	No

Wild Rice

Wild rice has been a culturally significant resource and a valuable food source for Native Americans for centuries. Wild rice is also recognized as an important food source for both migrating and resident wildlife. Birch Lake has been identified by the 1854 Treaty Authority and the MDNR as a wild rice water with potential to produce harvestable quantities of rice (MDNR, 2008). No other surface waters in the Project area are listed as wild rice waters by the MDNR.TMM has monitored wild rice in Birch Lake and other in the vicinity of the Project area since 2009.

Historic Review

To establish a baseline for wild rice in the Project area, publicly available documents containing information on the presence and absence of wild rice were reviewed. Local MDNR Fisheries offices in Minnesota store new and historical records regarding surface waters within their management zones which can include information of the presence of wild rice. Files from the Tower MDNR Fisheries office were reviewed for information on the presence of wild rice in the Project area. These documents include the Lake and Stream Survey Files generated and stored by the MDNR and regional resource documents, such as wild rice investigational reports and inventories. Hard copies of the MDNR data were reviewed at the Tower Fisheries office.

A Birch Lake file from the Tower Fisheries office was reviewed in paper format. The file contained numerous records describing vegetation and physical conditions in Birch Lake. Wild rice is specifically identified in the Lake Survey Reports for 1954, 1975, and 1997. MDNR Fisheries discontinued wild rice surveys after 1997.

The Tower Fisheries office did not have a Keeley Creek file.

In addition to the MDNR Fisheries files, wild rice investigational reports with regional or statewide significance were also reviewed. Some of the documents did not contain information about wild rice within the Project area. Information pertaining to wild rice is included in section *Baseline Results* .

Baseline Monitoring Methods

TMM has conducted baseline wild rice monitoring that has included surveys, macrophyte collection, and water quality monitoring. Wild rice survey and water quality monitoring methods used for the Project were similar to those used by the 1854 Treaty Authority, "Wild Rice Monitoring and Abundance in the 1854 Ceded Territory (1998–2017)" (Vogt, 2018) and other vegetation plot data surveys designed to quantify in situ plant species (e.g., The Relevé Method [MDNR, 2007]). In summary, these methods include qualitative (shoreline surveys) and quantitative (grid sampling) of wild rice stand density measurements and in-situ (in the field) and ex-situ (in the lab) wild rice plant measurements and statistical analyses. Wild rice sampling and processing was done as part of 2018 wild rice survey along with identifying other aquatic macrophytes growing in or near wild rice stands. The purpose of these observations and the sampling was to provide an overview of dominant macrophyte species in the water bodies. Observations of more common macrophyte species were noted, but not collected.

Baseline Results Birch Lake

The locations of wild rice stands were identified and plant densities were measured as shown on Figure 8-10 during field surveys conducted in August and September 2018. Wild rice was present along 39.8% (46.7 miles [75 km]) of the surveyed shoreline. A total of 120 wild rice plants were collected from eight field grids in 2018. These wild rice plants were all processed in the fall of 2018.

A total of 69 species of aquatic macrophytes have been collected or observed in or near identified wild rice stands during field surveys conducted annually between 2014 and 2018. The number of macrophyte species collected between 2014 and 2018 ranged between 41 and 48 species. In 2018, 31 water samples were collected from water bodies near wild rice stands. Macrophyte species observed include, but are not limited to: common spikerush, Canadian waterweed, small floating mannagrass, yellow pond-lily, American white waterlily, pickerelweed, long-leaf pondweed, broadleaf arrowhead, and floating bur-reed.

8.2 Project Impacts

This section describes the potential Project impacts to terrestrial resources and aquatic resources.

8.2.1 Terrestrial Resources

This section describes the potential Project impacts to terrestrial habitat, terrestrial vegetation, and terrestrial wildlife resources.

8.2.1.1 Terrestrial Habitat Effects

Impacts would primarily occur as a result of the Project construction. Clearing and grubbing of the access roads, water intake corridor / facility, tailings management site, plant site, ventilation raise sites, and ventilation access road, would directly impact the habitats within the area of potential ground disturbance. After clearing and grubbing, these sites would be graded and filled with crushed stone and supporting infrastructure would be constructed. During the Project operation phase habitat would not be re-established on these sites. The tailings management site would incorporate concurrent reclamation during operations. Concurrent reclamation involves the creation of areas that can be reclaimed as soon after initiation of the operation as practical and as continuously as practical throughout the life of the operation.

Habitat in the transmission corridor is also within the areas of potential ground disturbance of the Project and would be impacted by the footprint of the power line poles and parallel two-track maintenance trail. The transmission corridor would not be graded or filled with crushed stone and would be maintained to prevent tall-growing vegetation from interfering with the overhead power lines and associated infrastructure. This would allow for the reestablishment of primarily open grass / shrub habitat. The transmission corridor would be maintained in permanent vegetative cover and potentially provide shelter and food for wildlife in the area. The transmission corridor would allow for wildlife to traverse the corridor.

To reduce potential habitat impacts, the surface facilities have been designed on a compact layout to minimize the areas of potential ground disturbance, as described in Section 3.6.2.

Habitat impacts due to the Project would be of limited duration and at closure the habitats would be reclaimed to restore affected habitats. The Project would preserve the original soil by segregating and stockpiling organic soil for reclamation purposes. To bolster success of reclamation the Project would establish reference sites and revegetation plots. The reference sites would be undisturbed areas established prior to construction where vegetation type and quality would be documented. Revegetation would use the standards of Minn. R., chapter 6132, specifically that within ten growing seasons following the initiation of vegetation, the vegetative community would have characteristics similar to those of the approved reference sites.

Habitat Loss Effects

Construction of the surface facilities of the Project would impact 1,156 acres (467.8 ha) of habitat (Table 8-24 through Table 8-39). As discussed in Section 4.1.1 and 8.1.1, much of this habitat has been previously disturbed by human activity. The Project would reduce the available habitats within the Project area during Project construction and operation by 16.8%. Using the habitat classifications, the major habitat losses due to Project construction would be:

- USGS GAP / LANDFIRE- Boreal White Spruce-Fir-Hardwood Forest and Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen habitats (USGS, 2011b). Total impacts from the Project are shown in Table 8-24 through Table 8-31; and
- USGS NLCD-Woody Wetlands, Evergreen Forest, and Shrub / Scrub habitats (USGS, 2011a). Total impacts from the Project are shown in Table 8-32 through Table 8-39.

These habitats are common in Northern Minnesota and make up a significant portion of the Rainy River Headwaters watershed portion of the Border Lake subsection, as shown in Table 8-24 through Table 8-39).

Table 8-24 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Project Area

GAP Classification	Project Impacts (acres)[1]	Acres in Rainy River - Headwaters Watershed Portion of Border Lakes Subsection	% Reduction in Acres
Boreal Aspen-Birch Forest	43.0	102,849	0.04%
Boreal Jack Pine-Black Spruce Forest	127.3	68,576	0.19%
Boreal White Spruce-Fir-Hardwood Forest	517.2	502,604	0.10%
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	420.8	228,560	0.18%
Cultivated Cropland	0.0	187	0.00%
Developed, High Intensity	1.1	2,372	0.05%
Developed, Low Intensity	0.0	462	0.00%
Developed, Open Space	0.2	821	0.02%
Eastern Boreal Floodplain	0.5	3,237	0.02%
Harvested Forest - Grass/Forb Regeneration	0.4	2,555	0.02%
Laurentian-Acadian Floodplain Systems	0.4	7,535	0.01%
Laurentian-Acadian Northern Hardwoods Forest	5.2	7,909	0.07%
Laurentian-Acadian Northern Pine-(Oak) Forest	18.1	61,636	0.03%
Laurentian-Acadian Swamp Systems	9.5	10,207	0.09%
Open Water (Fresh)	8.2	215,656	0.00%
Quarries, Mines, Gravel Pits and Oil Wells	3.3	726	0.45%
Other	0.0	34,691	0.00%
Total	1155.2	1,250,582	0.09%

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-25 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Plant Site

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	1.7
Boreal Jack Pine-Black Spruce Forest	15.3
Boreal White Spruce-Fir-Hardwood Forest	85.7
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	46.0
Cultivated Cropland	0.0
Developed, High Intensity	0.0
Developed, Low Intensity	0.0
Developed, Open Space	0.0
Eastern Boreal Floodplain	0.0
Harvested Forest - Grass/Forb Regeneration	0.2
Laurentian-Acadian Floodplain Systems	0.0
Laurentian-Acadian Northern Hardwoods Forest	0.0
Laurentian-Acadian Northern Pine-(Oak) Forest	1.0
Laurentian-Acadian Swamp Systems	2.5
Open Water (Fresh)	0.4
Quarries, Mines, Gravel Pits and Oil Wells	0.0
Total	152.8

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-26 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Tailings Management Site

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	15.3
Boreal Jack Pine-Black Spruce Forest	89.4
Boreal White Spruce-Fir-Hardwood Forest	254.2
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	270.8
Cultivated Cropland	0.0
Developed, High Intensity	1.1
Developed, Low Intensity	0.0
Developed, Open Space	0.2
Eastern Boreal Floodplain	0.1
Harvested Forest - Grass/Forb Regeneration	0.2
Laurentian-Acadian Floodplain Systems	0.0
Laurentian-Acadian Northern Hardwoods Forest	1.4
Laurentian-Acadian Northern Pine-(Oak) Forest	10.7
Laurentian-Acadian Swamp Systems	4.4
Open Water (Fresh)	5.3
Quarries, Mines, Gravel Pits and Oil Wells	0.0
Total	653.1

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-27 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Access Road

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	0.0
Boreal Jack Pine-Black Spruce Forest	6.8
Boreal White Spruce-Fir-Hardwood Forest	23.7
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	12.9
Cultivated Cropland	0.0
Developed, High Intensity	0.0
Developed, Low Intensity	0.0
Developed, Open Space	0.0
Eastern Boreal Floodplain	0.0
Harvested Forest - Grass/Forb Regeneration	0.0
Laurentian-Acadian Floodplain Systems	0.0
Laurentian-Acadian Northern Hardwoods Forest	0.0
Laurentian-Acadian Northern Pine-(Oak) Forest	0.1
Laurentian-Acadian Swamp Systems	0.0
Open Water (Fresh)	0.0
Quarries, Mines, Gravel Pits and Oil Wells	0.0
Total	43.5

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-28 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Transmission Corridor

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	24.7
Boreal Jack Pine-Black Spruce Forest	8.0
Boreal White Spruce-Fir-Hardwood Forest	105.4
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	35.1
Cultivated Cropland	0.0
Developed, High Intensity	0.0
Developed, Low Intensity	0.0
Developed, Open Space	0.0
Eastern Boreal Floodplain	0.4
Harvested Forest - Grass/Forb Regeneration	0.0
Laurentian-Acadian Floodplain Systems	0.4
Laurentian-Acadian Northern Hardwoods Forest	3.1
Laurentian-Acadian Northern Pine-(Oak) Forest	3.1
Laurentian-Acadian Swamp Systems	1.1
Open Water (Fresh)	2.2
Quarries, Mines, Gravel Pits and Oil Wells	3.3
Total	186.8

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-29 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Water Intake Corridor / Facility

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	0.0
Boreal Jack Pine-Black Spruce Forest	0.3
Boreal White Spruce-Fir-Hardwood Forest	3.9
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	3.2
Cultivated Cropland	0.0
Developed, High Intensity	0.0
Developed, Low Intensity	0.0
Developed, Open Space	0.0
Eastern Boreal Floodplain	0.0
Harvested Forest - Grass/Forb Regeneration	0.0
Laurentian-Acadian Floodplain Systems	0.0
Laurentian-Acadian Northern Hardwoods Forest	0.0
Laurentian-Acadian Northern Pine-(Oak) Forest	0.0
Laurentian-Acadian Swamp Systems	0.0
Open Water (Fresh)	0.0
Quarries, Mines, Gravel Pits and Oil Wells	0.0
Total	7.4

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-30 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Ventilation Raise Sites and Access Road

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	0.0
Boreal Jack Pine-Black Spruce Forest	0.7
Boreal White Spruce-Fir-Hardwood Forest	4.7
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	8.7
Cultivated Cropland	0.0
Developed, High Intensity	0.0
Developed, Low Intensity	0.0
Developed, Open Space	0.0
Eastern Boreal Floodplain	0.0
Harvested Forest - Grass/Forb Regeneration	0.0
Laurentian-Acadian Floodplain Systems	0.0
Laurentian-Acadian Northern Hardwoods Forest	0.0
Laurentian-Acadian Northern Pine-(Oak) Forest	0.3
Laurentian-Acadian Swamp Systems	0.6
Open Water (Fresh)	0.0
Quarries, Mines, Gravel Pits and Oil Wells	0.0
Total	15.0

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-31 U.S. Geological Survey GAP / LANDFIRE Data Impacts for the Non-Contact Water Diversion Area

GAP Classification	Project Impacts (acres)[1]
Boreal Aspen-Birch Forest	1.3
Boreal Jack Pine-Black Spruce Forest	6.8
Boreal White Spruce-Fir-Hardwood Forest	39.6
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	44.1
Cultivated Cropland	0.0
Developed, High Intensity	0.0
Developed, Low Intensity	0.0
Developed, Open Space	0.0
Eastern Boreal Floodplain	0.0
Harvested Forest - Grass/Forb Regeneration	0.0
Laurentian-Acadian Floodplain Systems	0.0
Laurentian-Acadian Northern Hardwoods Forest	0.7
Laurentian-Acadian Northern Pine-(Oak) Forest	2.9
Laurentian-Acadian Swamp Systems	0.9
Open Water (Fresh)	0.3
Quarries, Mines, Gravel Pits and Oil Wells	0.0
Total	96.6

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-32 National Land Cover Data Impacts for the Project Area

National Land Cover Data Classification	Project Impacts (acres)[1]	Acres in Rainy River - Headwaters Watershed Portion of Border Lakes Subsection	% Reduction in Acres
Deciduous Forest	44.7	137,409	0.03%
Developed, Open Space	33.8	7,492	0.45%
Developed, Low Intensity	0.0	647	0.00%
Emergent Herbaceous Wetlands	1.9	22,862	0.01%
Evergreen Forest	322.0	227,015	0.14%
Grassland/Herbaceous	47.1	24,755	0.19%
Mixed Forest	159.7	247,012	0.06%
Open Water	8.4	211,656	0.00%
Shrub/Scrub	167.6	71,587	0.23%
Woody Wetlands	370.2	300,042	0.12%
Other	0.0	2,155	0.00%
Total	1155.4	1,252,632	0.09%

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.

Table 8-33 National Land Cover Data Impacts for the Plant Site

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	7.8
Developed, Open Space	5.8
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	0.0
Evergreen Forest	19.0
Grassland/Herbaceous	15.3
Mixed Forest	35.5
Open Water	0.5
Shrub/Scrub	36.8
Woody Wetlands	32.2
Total	152.9

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-34 National Land Cover Data Impacts for the Tailings Management Site

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	5.1
Developed, Open Space	19.5
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	0.0
Evergreen Forest	181.9
Grassland/Herbaceous	28.9
Mixed Forest	96.1
Open Water	5.5
Shrub/Scrub	93.5
Woody Wetlands	222.7
Total	653.2

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-35 National Land Cover Data Impacts for the Access Road

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	0.0
Developed, Open Space	3.2
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	0.0
Evergreen Forest	30.6
Grassland/Herbaceous	0.0
Mixed Forest	1.1
Open Water	0.0
Shrub/Scrub	1.2
Woody Wetlands	7.5
Total	43.6

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-36 National Land Cover Data Impacts for the Transmission Corridor

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	30.5
Developed, Open Space	0.2
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	1.9
Evergreen Forest	45.5
Grassland/Herbaceous	1.6
Mixed Forest	15.9
Open Water	2.4
Shrub/Scrub	25.6
Woody Wetlands	63.2
Total	186.8

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-37 National Land Cover Data Impacts for the Water Intake Corridor

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	0.5
Developed, Open Space	0.0
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	0.0
Evergreen Forest	2.9
Grassland/Herbaceous	0.0
Mixed Forest	1.2
Open Water	0.0
Shrub/Scrub	0.3
Woody Wetlands	2.5
Total	7.4

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-38 National Land Cover Data Impacts for the Ventilation Raise Sites and Access Road

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	0.0
Developed, Open Space	0.9
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	0.0
Evergreen Forest	10.1
Grassland/Herbaceous	0.0
Mixed Forest	0.0
Open Water	0.0
Shrub/Scrub	0.0
Woody Wetlands	3.9
Total	14.9

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 8-39 National Land Cover Data Impacts for the Non-Contact Water Diversion Area

National Land Cover Data Classification	Project Impacts (acres)[1]
Deciduous Forest	0.8
Developed, Open Space	4.2
Developed, Low Intensity	0.0
Emergent Herbaceous Wetland	0.0
Evergreen Forest	32.0
Grassland/Herbaceous	1.3
Mixed Forest	9.9
Open Water	0.0
Shrub/Scrub	10.2
Woody Wetlands	38.2
Total	96.6

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

NPC and Rare Natural Community Effects

Some NPC have been identified within the areas of potential ground disturbance and would be impacted by construction of the surface facilities, as shown in Table 8-40. The surface disturbance would reduce the amount of NPC in the Project area by 19%. These NPC include 264.5 acres (107.0 ha) of NPC types and subtypes that have a conservation status rank of S2 or S3.

Table 8-40 Minnesota Department of Natural Resources Minnesota Biological Survey Data Impacts

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Project Impacts (acres)
APn81a	Poor Black Spruce Swamp	S5	65.0
APn81b	Poor Tamarack - Black Spruce Swamp	S4	5.5
APn81b1	Poor Tamarack - Black Spruce Swamp, Black Spruce Subtype	S4	0.0
APn81b2	Poor Tamarack - Black Spruce Swamp, Tamarack Subtype	S4	0.7
APn91a	Low Shrub Poor Fen	S5	3.9
APn91b	Graminoid Poor Fen (Basin)	S3	0.0
Acid Peatland	*System Total*	*not applicable*	*75.1*
CTn32a	Mesic Mafic Cliff (Northern)	S3	2.0
Cliff/Talus	*System Total*	*not applicable*	*2.0*
BW_CX	Beaver Wetland Complex	No S-Rank	7.2
Beaver Wetland	*Complex Total*	*not applicable*	*7.2*
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex	No S-Rank	107.2
Mesic Woodland/Mesic Forest	*Complex Total*	*not applicable*	*107.2*
FDn32	Northern Poor Dry-Mesic Mixed Woodland	No S-Rank	126.4
FDn32a	Red Pine - White Pine Woodland (Canadian Shield)	S3	0.0
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	284.9
FDn32c1	Black Spruce - Jack Pine Woodland, Jack Pine - Balsam Fir Subtype	S2	1.0
FDn33	Northern Dry-Mesic Mixed Woodland	No S-Rank	3.9
FDn33a	Red Pine - White Pine Woodland	S3	0.4
FDn43	Northern Mesic Mixed Forest	No S-Rank	0.0
FDn43a	White Pine - Red Pine Forest	S2	4.4
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	7.9
FDn43b2	Aspen - Birch Forest, Hardwood Subtype	S5	4.0
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*432.9*
FPn62a	Rich Black Spruce Swamp (Basin)	S3	3.7
Forested Rich Peatland	*System Total*	*not applicable*	*3.7*
OPn81	Northern Shrub Shore Fen	No S-Rank	0.0
OPn81b	Leatherleaf - Sweet Gale Shore Fen	S5	1.2
OPn91	Northern Rich Fen (Water Track)	No S-Rank	0.4
Open Rich Peatland	*System Total*	*not applicable*	*1.6*
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	S4	18.7
WFn64c	Black Ash - Alder Swamp (Northern)	S4	0.1
Wet Forest	*System Total*	*not applicable*	*18.8*

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Project Impacts (acres)
WMn82b1	Sedge Meadow, Bluejoint Subtype	S5	0.7
Wet Meadow/Carr	*System Total*	*not applicable*	*0.7*
All Subtypes	***Project Area* Biological Community Baseline**	**AcresTotal[1]**	649.2
APn91a	Low Shrub Poor Fen	S5	0.0
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	1.8
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	2.1
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*3.9*
WFn64c	Black Ash - Alder Swamp (Northern)	S4	0.1
Wet Forest	*System Total*	*not applicable*	*0.1*
All Subtypes	**Plant Site Biological Community Baseline**	**AcresTotal**	4.0
APn81a	Poor Black Spruce Swamp	S5	43.7
APn81b	Poor Tamarack - Black Spruce Swamp	S4	0.9
Acid Peatland	*System Total*	*not applicable*	*44.6*
CTn32a	Mesic Mafic Cliff (Northern)	S3	0.5
Cliff/Talus	*System Total*	*not applicable*	*0.5*
BW_CX	Beaver Wetland Complex	No S-Rank	6.5
Beaver Wetland	*Complex Total*	*not applicable*	*6.5*
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex	No S-Rank	74.1
Mesic Woodland/Mesic Forest	*Complex Total*	*not applicable*	*74.1*
FDn32	Northern Poor Dry-Mesic Mixed Woodland	No S-Rank	121.8
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	205.5
FDn32c1	Black Spruce - Jack Pine Woodland, Jack Pine - Balsam Fir Subtype	S2	0.6
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	1.3
FDn43b2	Aspen - Birch Forest, Hardwood Subtype	S5	4.0
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*333.2*
FPn62a	Rich Black Spruce Swamp (Basin)	S3	2.7
Forested Rich Peatland	*System Total*	*not applicable*	*2.7*
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	S4	10.7
Wet Forest	*System Total*	*not applicable*	*10.7*
All Subtypes	**TMS Biological Community Baseline**	**AcresTotal**	472.3
APn81a	Poor Black Spruce Swamp	S5	1.0
APn81b2	Poor Tamarack - Black Spruce Swamp, Tamarack Subtype	S4	0.5
Acid Peatland	*System Total*	*not applicable*	*1.5*
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	22.0
FDn33	Northern Dry-Mesic Mixed Woodland	No S-Rank	3.9
FDn43a	White Pine - Red Pine Forest	S2	4.3

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Project Impacts (acres)
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	0.1
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*30.3*
FPn62a	Rich Black Spruce Swamp (Basin)	S3	0.5
Forested Rich Peatland	*System Total*	*not applicable*	*0.5*
All Subtypes	**Access Road Biological Community Baseline**	**AcresTotal**	32.3
APn81a	Poor Black Spruce Swamp	S5	2.2
APn81b	Poor Tamarack - Black Spruce Swamp	S4	2.1
APn81b2	Poor Tamarack - Black Spruce Swamp, Tamarack Subtype	S4	0.3
APn91a	Low Shrub Poor Fen	S5	3.9
Acid Peatland	*System Total*	*not applicable*	*8.5*
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex	No S-Rank	10.5
Mesic Woodland/Mesic Forest	*Complex Total*	*not applicable*	*10.5*
FDn32	Northern Poor Dry-Mesic Mixed Woodland	No S-Rank	3.2
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	25.4
FDn32c1	Black Spruce - Jack Pine Woodland, Jack Pine - Balsam Fir Subtype	S2	0.3
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	2.7
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*31.6*
OPn81b	Leatherleaf - Sweet Gale Shore Fen	S5	1.2
OPn91	Northern Rich Fen (Water Track)	No S-Rank	0.4
Open Rich Peatland	*System Total*	*not applicable*	*1.6*
WMn82b1	Sedge Meadow, Bluejoint Subtype	S5	0.7
Wet Meadow/Carr	*System Total*	*not applicable*	*0.7*
All Subtypes	**Transmission Corridor Biological Community Baseline**	**Acres Total**	52.9
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex	No S-Rank	6.2
Mesic Woodland / Mesic Forest	*Complex Community Total*	*not applicable*	*6.2*
All Subtypes	**Water Intake Corridor / Facility Biological Community Baseline**	**AcresTotal**	6.2
APn81a	Poor Black Spruce Swamp	S5	0.4
Acid Peatland	*System Total*	*not applicable*	*0.4*
FDn33a	Red Pine - White Pine Woodland	S3	0.4
FDn43a	White Pine - Red Pine Forest	S2	0.1
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	1.6
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*2.1*
FPn62a	Rich Black Spruce Swamp (Basin)	S3	0.4

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Project Impacts (acres)
Forested Rich Peatland	*System Total*	*not applicable*	*0.4*
All Subtypes	**Ventilation Raise Sites and Access Road Biological Community Baseline**	**AcresTotal**	2.9
APn81a	Poor Black Spruce Swamp	S5	17.9
APn81b	Poor Tamarack - Black Spruce Swamp	S4	2.5
Acid Peatland	*System Total*	*not applicable*	*20.4*
CTn32a	Mesic Mafic Cliff (Northern)	S3	1.5
Cliff/Talus	*System Total*	*not applicable*	*1.5*
BW_CX	Beaver Wetland Complex	No S-Rank	0.7
Beaver Wetland	*Complex Total*	*not applicable*	0.7
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex	No S-Rank	16.4
Mesic Woodland/Mesic	*Forest Complex*	*not applicable*	*16.4*
FDn32	Northern Poor Dry-Mesic Mixed Woodland	No S-Rank	1.5
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	30.2
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	0.1
Fire-Dependent Forest/Woodland	*System Total*	*not applicable*	*31.8*
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	S4	8.0
Wet Forest	*System Total*	*not applicable*	*8.0*
All Subtypes	**Non-Contact Water Diversion Area Biological Community Baseline**	**AcresTotal**	78.8

Notes:
[1] MBS NPC/candidate data is not available for the full Project area. Southwest portion of the transmission corridor has not been mapped.
Abbreviations:
MBS = Minnesota Biological Survey
NPC = Native Plant Community

At an ecological systems level, NPCs that would be impacted by the Project, specifically Fire-Dependent Forest / Woodland, Mesic Forest Complex, and Acid Peatland System communities, are abundant in the region around the Project area. The impacts resulting from the Project would not reduce the regional abundance of these NPCs at an ecological systems level, e.g. where NPC exist:

- Within 5 miles of the Project area Fire-Dependent Forest / Woodland, Complex Community (including Mesic Forest Complex), and Acid Peatland System communities make up 57.5%, 13.4%, and 22.6% respectively.

While the NPCs at the ecological systems level are common within the Project area and region, insufficient information is available to determine whether specific NPC classes, types, and subtypes could be impacted by the Project. Most of the NPC data has been developed remotely and while sufficient to describe NPCs at an ecological systems level the data is less accurate when categorizing specific NPC classes, types, and subtypes.

Habitat Fragmentation Effects

Ground disturbance could lead to habitat fragmentation, a process by which large and contiguous habitats get divided into smaller, isolated patches of habitats. The results of habitat fragmentation could cause:

- Population fragmentation: this occurs when groups of animals become separated from other groups of the same species increasing the possibility of compromising the long-term survival of the species in the area;
- Ecosystem decay: this occurs when populations of species are isolated leading to inbreeding and a decrease in the population of local species; and
- Edge effects: this occurs when there are changes in the amount of wind and sunlight available to understory vegetation which could lead to population changes of vegetation and wildlife.

Existing disturbances within the Project, including approximately 40 miles (64 km) of existing roads and trails, have caused habitat fragmentation. The Project would further alter the forest cover in the area by adding 12.5 miles (20.1 km) of corridors and roads and 1,156 acres (467.8 ha) of surface facilities that have the potential to fragment habitats. However, the compact design and temporary nature of the Project would reduce the potential for significant effects.

Population fragmentation and ecosystem decay occur at larger scales and the potential for these effects due to the Project would be reduced due to the small scale and abundant suitable habitat in and near the Project area. Additionally, edge effects would likely occur at a localized scale and would be reduced by the abundance of suitable habitat undisturbed by the Project. The effects would be temporary during Project construction and operation and reclamation would promote the re-establishment of habitat, vegetation, and wildlife to reverse the potential effects of fragmentation.

Wildlife Corridor Effects

Wildlife corridors serve as a link for wildlife between habitats within their ranges. Previous studies (Emmons & Oliver Resources, Inc. [EOR], 2006 and Barr, 2009) show that the greatest impacts to wildlife corridors in northern Minnesota, specifically on the Iron Range southwest of the Project area, are related to urban developments and mine operations. Large open mine pits, conventional tailings basins, and networks of haul roads were identified as the primary disruptions to wildlife corridors from mine operations. The size of the surface features and the scale of their respective impacts described in those reports are orders of magnitude greater than the Project's potential ground disturbance. For example, the Barr (2009) report cited MDNR data that "mining features cover 118,315 acres along the Iron Range, including 36,962 acres of open mine pits, 78,620 acres of stockpiles and tailings basins, and 212 acres of facilities and infrastructure." Currently, there are six active permitted operations in addition to several other inactive permitted operations.

The Project is in an area that has physical limits in providing a wildlife corridor. The Project area is bounded to the north and the west by Birch Lake which could present a physical or behavioral impediment to terrestrial species of wildlife. Recreation use of Birch Lake during spring, summer, and fall months may deter species that would typically cross bodies of water and previous and current disturbances, including existing forest roads and rural residential roads, intersect the Project area and influence the movement of wildlife. No specific corridors have been identified within the Project area and there is abundant contiguous habitat to the east of the Project area which wildlife would preferentially use.

Terrestrial Habitat Impacts Summary

Available information to fully assess potential Project impacts to terrestrial habitat is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- The Project would alter the habitat in the Project area adding 12.5 miles (20.1 km) of corridors and roads and 1,156 acres (467.8 ha) acres of surface facilities that have the potential to fragment habitats; and
- The magnitude of terrestrial habitat impacts would be minor because: 1) habitat types and NPC found within the area of potential ground disturbance are common within the Project area and the Rainy River Headwaters watershed; 2) habitat fragmentation effects would be reduced by the existing disturbances in the area, the limited geographic extent of the Project, and the temporary nature of the Project; and 3) similar habitat in and near the Project area would be undisturbed and have restricted development potential due to public ownership.

Future work to assess potential impacts to terrestrial habitat is outlined in Section 8.3.1.

8.2.1.2 Terrestrial Vegetation

Common Terrestrial Vegetation Effects

This section discusses the potential effects to individual species in contrast to the Terrestrial Habitat Effects that discussed effects to terrestrial habitats and communities. Clearing, grubbing, and construction of the surface facilities would result in the removal of existing vegetation. As discussed in the Terrestrial Habitat Effects, these habitat types and NPC are common in the Project area, the region around the Project area, and the Rainy River Headwaters watershed; and the impacts from the Project would not present a significant change to the regional distribution of vegetative species.

Reclamation and revegetation plans would reduce the duration of impacts by reclaiming the Project back to a natural area consistent with the surrounding landscapes. Vegetation impacts are temporary and reversible through concurrent reclamation of the tailings management site and reclamation of other surface disturbances such as the plant site at closure.

Sensitive Vegetative Species Effects

Based on the habitat data there is the potential for sensitive vegetative species to be present within the Project area. Sensitive vegetative species were reviewed for their habitat associations. Habitats that are associated with sensitive vegetative species are considered to potentially contain sensitive species. These habitats, if present in areas of potential ground disturbance, would indicate a potential for impact to sensitive vegetative species. Potential effects would be from the removal of vegetation during clearing, grubbing, and construction. The species that could be impacted by the Project are shown in Table 8-9 through Table 8-12. There is potential for the Project to impact sensitive species based on habitat associations; however, inadequate information is available to verify whether sensitive species are present.

Non-native Invasive Plants Effects

A limited number of non-native invasive plants have been identified in the Project area including three species of plants on the MDA control list. There is a potential to increase populations of non-native invasive plants through the construction activities associated with the Project. During clearing and grubbing activities, soils would be exposed, which provides a pathway for non-native invasive plants to be established in the seed bed. This can occur through various vectors including natural spread of seed or plant material and transportation by construction equipment. During construction, operation, closure, and post-closure, selective weed control practices would be implemented to limit the growth and spread of non-native invasive plants, including noxious weeds.

Prior to construction a non-native invasive plant survey would be conducted to identify the location, type, and extent of non-native invasive plants within the potential area of disturbance. A non-native invasive vegetation management plan would be developed, which would include BMPs for avoiding exposure to areas of non-native invasive plants, cleaning vehicles which may have come in contact with non-native invasive plants and removing or controlling non-native invasive plants near areas of potential ground disturbance to minimize further propagation.

A variety of weed control techniques would be considered and used as necessary. Weed monitoring would be conducted for the life of the operation. If the spread of noxious weeds is noted, weed control procedures would be developed in consultation with USFS personnel and would be in compliance with USFS handbooks and the Minnesota Noxious Weed List. Additionally, during reclamation, mowing may be used along with herbicide treatments where weed control is necessary to achieve reclamation revegetation goals. Specific herbicides would be carefully selected to target noxious weed species needing control, taking into account their extent of growth.

The potential effects of non-native invasive vegetation from the Project would be minor, for the following reasons:

- The small number of non-native invasive plants identified on site;
- The EPMs to control temporary impacts; and

- The reversibility by reclamation of the Project at closure.

Terrestrial Vegetation Impacts Summary

Available information to fully assess potential Project impacts to terrestrial vegetation is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- The potential impacts from the Project would not present a significant change to the regional distribution of vegetative species;
- No federally-listed endangered or threatened vegetative species were identified as present within the areas of potential ground disturbance;
- There is a potential for the Project to affect state threatened and endangered vegetative species, vegetative species on the RFSS, and state species of special concern, but insufficient information exists to confirm the presence of these listed species.
- A small number of non-native invasive plants were identified on site and would be controlled by BMPs and non-native invasive species management plans.

Future work to assess potential impacts to terrestrial vegetation is outlined in Section 8.3.1.

8.2.1.3 Terrestrial Wildlife Resources

Common Terrestrial Wildlife Effects

Direct effects from the Project would primarily occur during the clearing, grubbing, and construction of Project infrastructure. Direct impacts include habitat loss, habitat fragmentation, species displacement, and mortality. More mobile species would be able to relocate into the surrounding environment where suitable habitat is abundant. Species with less mobility would have an increased potential of direct impact from the Project construction as they are less likely to be able to relocate and avoid encounters with ground disturbing activities.

Examples of common less mobile terrestrial species potentially associated with habitats within areas of potential ground disturbance would be:

- Reptiles;
- Mammals: mice, voles, and rats, shrews, bats;
- Insects; and
- Arachnids.

Examples of common more mobile terrestrial species potentially associated with habitats within areas of potential ground disturbance would be:

- Mammals: white-tailed deer, black bear, fox, coyotes, porcupine, raccoons, skunks, beaver, hares, and rabbits; and
- Birds.

As discussed in Terrestrial Habitats, similar habitats exist adjacent to the Project area increasing the probability that mobile species could successfully relocate into adjacent habitats. Direct impacts to nests, burrows, or hibernating wildlife (depending on seasonality) could occur. The Project would be unlikely to significantly affect regional populations of any of these species as these habitats are common within the region around the Project area and the Rainy River Headwaters watershed. Individuals displaced from these sites would be able to assimilate into suitable adjacent habitat.

Wildlife can hear sound frequencies, many of which are inaudible to humans. Wildlife will often habituate to noise, especially noises that are steady or continuous but are less likely to habituate to sudden, infrequent impulse noises. These sudden, infrequent impulse noises such as back up alarms on mobile equipment or material handling at the plant site and tailings management site, could displace a variety of wildlife found in and around the Project area, including mammals and birds many of which could successfully relocate into adjacent habitats. The Project would aim to reduce the impact of both sudden, infrequent impulse noises and steady or continuous to receptors outside the Project footprint by ensuring noise levels remain below the NAC-1 nighttime limit of 50 dBA. At this level, impacts would be limited to sensitive receptors proximal to the plant site, tailings management site and the potential significance of the impacts of noise on wildlife would be reduced.

Lighting and glare from the Project would result in some nocturnal wildlife avoiding the Project area. Wildlife, particularly nocturnal species, would avoid the Project area and a buffer around it depending on how lighting was positioned and managed. EPMs identified in Section 10.2 would reduce the significance of potential effects to wildlife.

The Project would increase vehicular traffic on public roads within the Project area. This increases the potential for wildlife encounters with vehicles, leading to some increased chance of vehicle strikes. Several EPMs would be implemented to minimize this potential effect. The Project would utilize employee busing to greatly reduce the traffic generated to the Project. Road designs would utilize appropriately sized clear zones to increase driver visibility and the Project would incorporate safe driving practices into their standard operating procedures. The impacts on traffic and EPMs are outlined further in Section 13.2. These EPMs reduce the potential for significant effects to wildlife from traffic.

Sensitive Terrestrial Wildlife Species Effects

Based on the habitat data there is the potential for sensitive wildlife species to be present within the Project area. Sensitive wildlife species were reviewed for their habitat associations. Habitats that are associated with sensitive wildlife species are considered to potentially contain those species. These habitats, if present in areas of potential ground disturbance, would indicate a potential for impact to sensitive wildlife species. Potential impacts would primarily occur during the clearing, grubbing, and construction of Project infrastructure. The species that could potentially be impacted by the Project are shown in Table 8-13 to Table 8-17. There is potential for the Project to impact sensitive species based on habitat associations; however, inadequate information is available to verify whether sensitive wildlife species are present.

Terrestrial Wildlife Impacts Summary

Available information to fully assess potential Project impacts to terrestrial wildlife is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- Direct impacts would include habitat loss, habitat fragmentation, species displacement, or mortality;
- The extent of habitat loss would be small in contrast to the available habitat within the region. The Project is unlikely to significantly affect regional populations of any of these species as these habitats are common within the region and the surrounding area of the SNF;
- Impacts from noise, lighting, and glare would be reduced following EPMs and designs outlined in Section 12.2 and Section 10.2 respectively;
- There is a potential for wildlife encounters with vehicles, leading to some increased chance of vehicle strikes which would be reduced using EPMs and BMPs;
- There is a potential for the Project to affect federal and state threatened and endangered terrestrial wildlife species, terrestrial wildlife species on the RFSS list, and terrestrial wildlife state species of special concern, but insufficient information exists to confirm the presence of any of the listed species.

Future work to assess potential impacts to terrestrial vegetation is outlined in Section 8.3.1.

8.2.2 Aquatic Resources

This section describes the potential Project impacts to aquatic habitat, aquatic biota, and wild rice.

8.2.2.1 Aquatic Habitat

The placement of the water intake pipe on the bed of Birch Lake would be a direct effect to the littoral area of the reservoir. The disturbance, as described in the section *Water Intake Corridor,* would affect an estimated 0.25 acres (0.1 ha) of littoral area. MDNR indicates that there is 1,060 acres (429 ha) of littoral area on Birch Lake. This change in littoral area would be insignificant.

Water appropriation could also have a direct impact on the aquatic habitat in Birch Lake. However, as described in Section 6.2.1, the impact of water appropriations would be insignificant compared with the seasonal and managed water level fluctuation of the reservoir and would not impact the aquatic habitat of Birch Lake.

Streams would be crossed by overhead power lines and no direct effect to the stream habitat would occur. The transmission corridor would be designed to avoid impacts to the watercourses. During construction of the transmission corridor, the Project would use BMPs which may include temporary control measures such as silt fences, sediment logs, and other industry standard construction stormwater controls.

The tailings management site would be sufficiently set back with design and EPMs to avoid impacts to Keeley Creek related to surface disturbance. Consideration for changes to groundwater or surface water flow to Keeley Creek are included in Section 6.3.

8.2.2.2 Aquatic Biota

Project water management would avoid and minimize the potential for impacts to aquatic biota. Specifically, the Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water. Further, non-contact water would be managed to reduce sediment transport.

Potential water resources impacts related to surface water quality and quantity (Section 6.2) could result in impacts to aquatic biota, however the nature and extent of these water resources impacts are currently unknown and will be evaluated in the future scopes of work outlined in Section 6.3.

8.2.2.3 Wild Rice

The Project has been designed to minimize the release of sulfate and potential effects to wild rice through water management practices. The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water. Engineered designs of contact water ponds and dry stack facility facilities that would reduce the likelihood of seepages or discharges are incorporated.

Potential water resources impacts related to surface water quality and quantity (Section 6.2) could result in impacts to wild rice, however the nature and extent of these water resources impacts are currently unknown and will be evaluated in the future scopes of work outlined in Section 6.3

8.2.2.4 Aquatic Resources Impacts Summary

Available information to fully assess potential Project impacts to aquatic resources is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- Potential impacts to aquatic habitats associated with the construction of the water intake pipe would be insignificant. No other impacts to aquatic habitats from Project construction are expected;
- Potential water resources impacts related to surface water quality and quantity) could result in impacts to aquatic resources, however the nature and extent of these water resources impacts are currently unknown and will be evaluated in the future scopes of work outlined in Section 6.3

No future scope of work exclusive to aquatic resources is proposed. Potential impacts to aquatic resources will be assessed using results from the future scope for water resources outlined in Section 6.3.

8.3 Future Scope

8.3.1 Terrestrial Resources

8.3.1.1 Habitat, Vegetative, and Wildlife Baseline Surveys

Purpose

TMM proposes a scope of work to conduct habitat, vegetative, and wildlife surveys in the Project area with the purpose of:

- Determining the occurrence of NPC class, types, and subtypes, including rare natural communities or high-quality NPCs, as referenced in Minn. R., part 8420.0515, subpart 3;
- Creating a plant community map and recording evidence of natural or anthropogenic disturbances to document previous impacts to habitats, vegetation, and wildlife;
- If present, locating and documenting sensitive vegetative populations;
- Conducting an inventory of the sensitive wildlife and general wildlife species;
- Identifying areas providing important or critical habitat to sensitive wildlife species;
- Assessing habitat quality and the ability of the Project area to provide suitable habitat for sensitive wildlife species, and
- Compiling a list of all wildlife species observed during surveys.

This survey will help refine the baseline habitat, vegetative, and wildlife conditions and identify possible reduction measures that the Project could implement to limit impacts. This work will also inform potential permit applications pertaining to the taking of listed species under Minn. R., part 6212.1800, if applicable.

Terrestrial Resources Questions to be Answered

The scope of work is developed to answer specific questions for the agencies to make a decision on the scope of the EIS.

- What are the NPC classes, types, and subtype within the Project area and area of potential ground disturbance?
- What is the presence or absence of vegetative sensitive species, specifically those with protected statuses within the Project area and area of potential ground disturbance?
- What is the presence or absence of high-quality NPCs and classify the quality of any rare native plant communities identified within the Project area and area of potential ground disturbance?
- Do Project EPMs or reduction methods to reduce impacts to vegetative sensitive species, high quality NPCs, or rare native plant communities need to be revisited?

- What is the presence or absence of sensitive wildlife species, specifically those with protected statuses within the Project area and area of potential ground disturbance?
- Do Project EPMs or reduction methods to reduce impacts to sensitive wildlife species need to be revisited?
- Does the Project have the potential for significant effects to habitat, vegetative, and wildlife?

Approach

TMM proposes the work in three phases. The phases are generally sequential and will lead to a supporting report or technical memorandum as a reference document.

Phase 1 – Pre-field research on habitats, vegetation, and wildlife. *Habitat and vegetation* – This phase will build off the baseline conditions of the SEAW and using additional remote sensing and desktop sources to evaluate the types of habitat and vegetative cover present. This phase will also include compilation of information on plant associations, phenology, and key identifying characteristics for a list of species that were most likely to be present as identified in the SEAW. *Wildlife* – Similar to the habitat and vegetation phase, this will evaluate the types of sensitive species potentially present. This phase will also include compilation of information on wildlife associations and survey methodology.

Phase 2 – Terrestrial vegetation baseline surveys. The field survey is designed to:

- Create a plant community map using aerial photograph interpretation and spot verification with global positioning system (GPS) that will enable mapping of cover type.
- Conduct "meanders surveys" within the community, in conjunction with topographic maps and air photos, to generally document variability and microhabitats.
- Gather information on the composition, structure, and function that enables characterization, qualitative ranking, and classification to community type.
- Record evidence of disturbance, whether natural or anthropogenic, recent or in the distant past, as it relates to biological communities. Where possible, the severity of impact and degree of recovery or potential for recovery will be estimated.
- Conduct plant surveys throughout representative portions of NPCs. Conduct surveys on a controlled intuitive or meander basis.
- Observe and note ecological and abiotic factors which may influence the NPC's potential to harbor rare plant species.
- Perform three, one-week field visits to cover the various blooming periods and target field work for time windows when known of suspected rare species will be easiest to identify.
- Record observations of non-listed and invasive plant species identified as "prohibited" under the Minnesota Noxious Weed Law.
- If present, rare plant populations will be located and documented.

Phase 3 – Terrestrial wildlife baseline surveys. The field survey is designed to:

- Identify areas providing important or critical habitat for state and federal threatened or endangered species;
- Provide an assessment of the habitat quality and the ability of the Project area to provide suitable habitat for sensitive, threatened, or endangered wildlife species. In addition, identify any factors affecting or potentially affecting the quality of the habitat; and
- Compile a supplemental list of all wildlife species observed during prescribed surveys.

Wildlife surveys will be conducted using the following procedures:

Birds

- Standardized bird point count survey methods will be used to determine presence of threatened and endangered songbirds breeding within the Project area;
- A game bird brood survey will be completed by recording broods observed while completing normal field operations. Brood surveys will be conducted in conjunction with other wildlife and site surveys being completed on the Project area;
- Nocturnal bird species surveys will be completed for owls and nightjars. Approximately 10 owl and nightjar monitoring stations will be equally spaced approximately 1 mile from each other along the existing forest roads and trail system of the Project area; and
- In addition to the standardized bird surveys and species-specific bird surveys described, incidental observations of bird species detected during other routine work performed on the Project area will be recorded and summarized.

Bats, Reptiles, and Amphibians

- Bat, reptile, and amphibian surveys will be conducted during three weeklong periods;
- An inventory of bats occupying the various habitats of the Project area will be conducted using acoustic bat detection equipment;
- Reptile surveys will be completed using visual meander or trapping techniques;
- Amphibian surveys will be completed by surveying wetland areas near dusk and recording amphibian calls; and
- Incidental observations of other reptile / amphibian species will be catalogued during field surveys.

Mammals

- Digital camera trap surveys will utilize up to 10 motion-detection cameras spaced throughout the Project area. The cameras will be used in conjunction with bait / scent stations. The cameras will be monitored throughout the wildlife field assessments;
- Small mammal surveys will be completed using baited live traps; and

- Incidental observations of other mammal species will be catalogued during the winter tracking and digital camera trap surveys, and other routine work performed on the Project area.

Deliverables

The result of this work will be combined with the results from the Wetlands Baseline work outlined in Section 6.3.1 and will be included in two reports.

- Project area Wetland and Terrestrial Biology–Volume 1 Baseline Data and Methods, and
- Project area Wetland and Terrestrial Biology–Volume 2 Baseline Conditions.

8.3.2 Aquatic Resources

Potential impacts to aquatic resources from changes to water quality or water quantity will be assessed using results from the future scope for water resources outlined in Section 6.3. Additionally, the future work scope planned for cross-media impacts described in Section 6.3 will inform potential impacts to aquatic resources from deposition and accumulation of metals and sulfate.

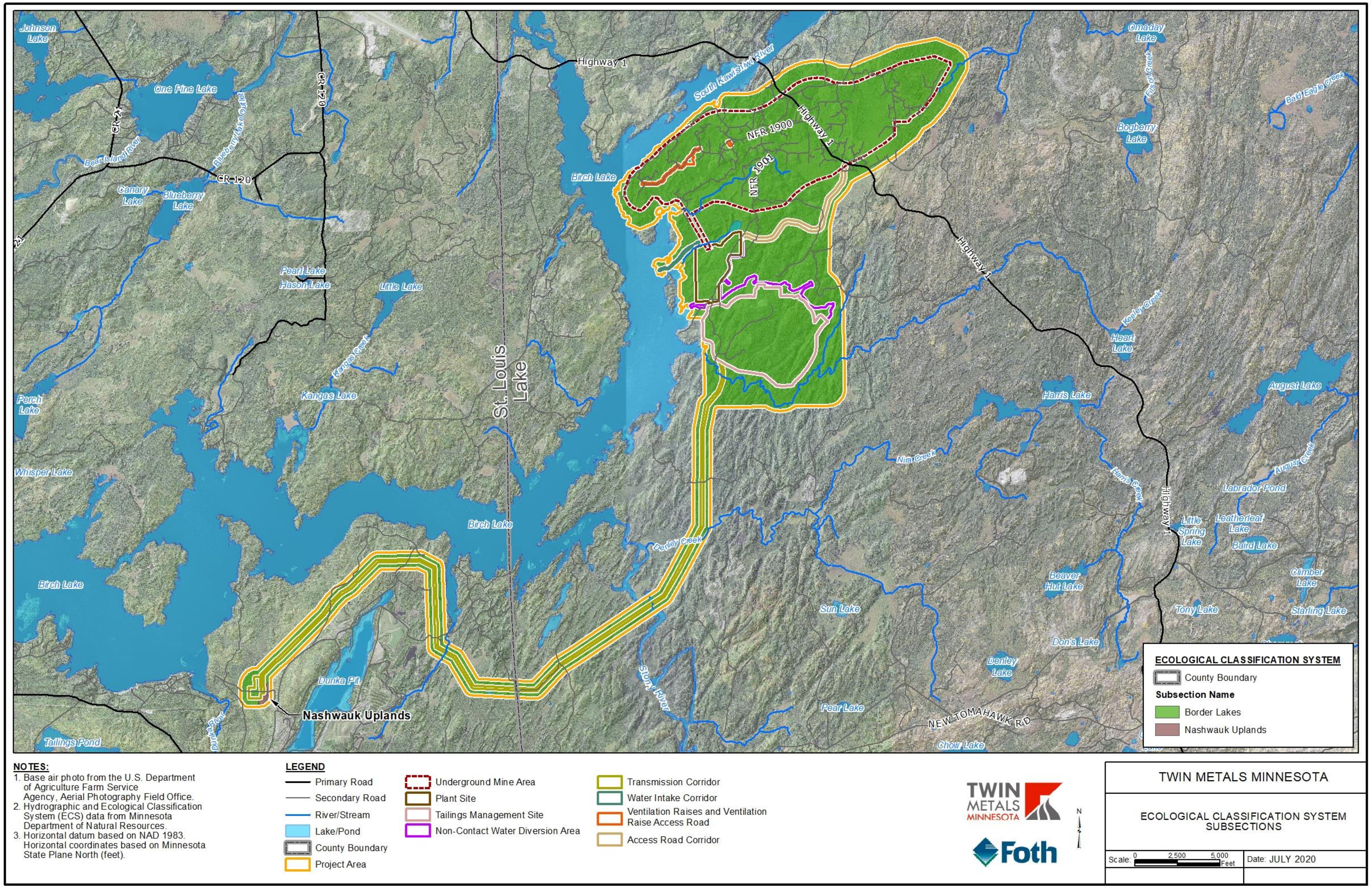


Figure 8-1 Ecological Classification System Subsections

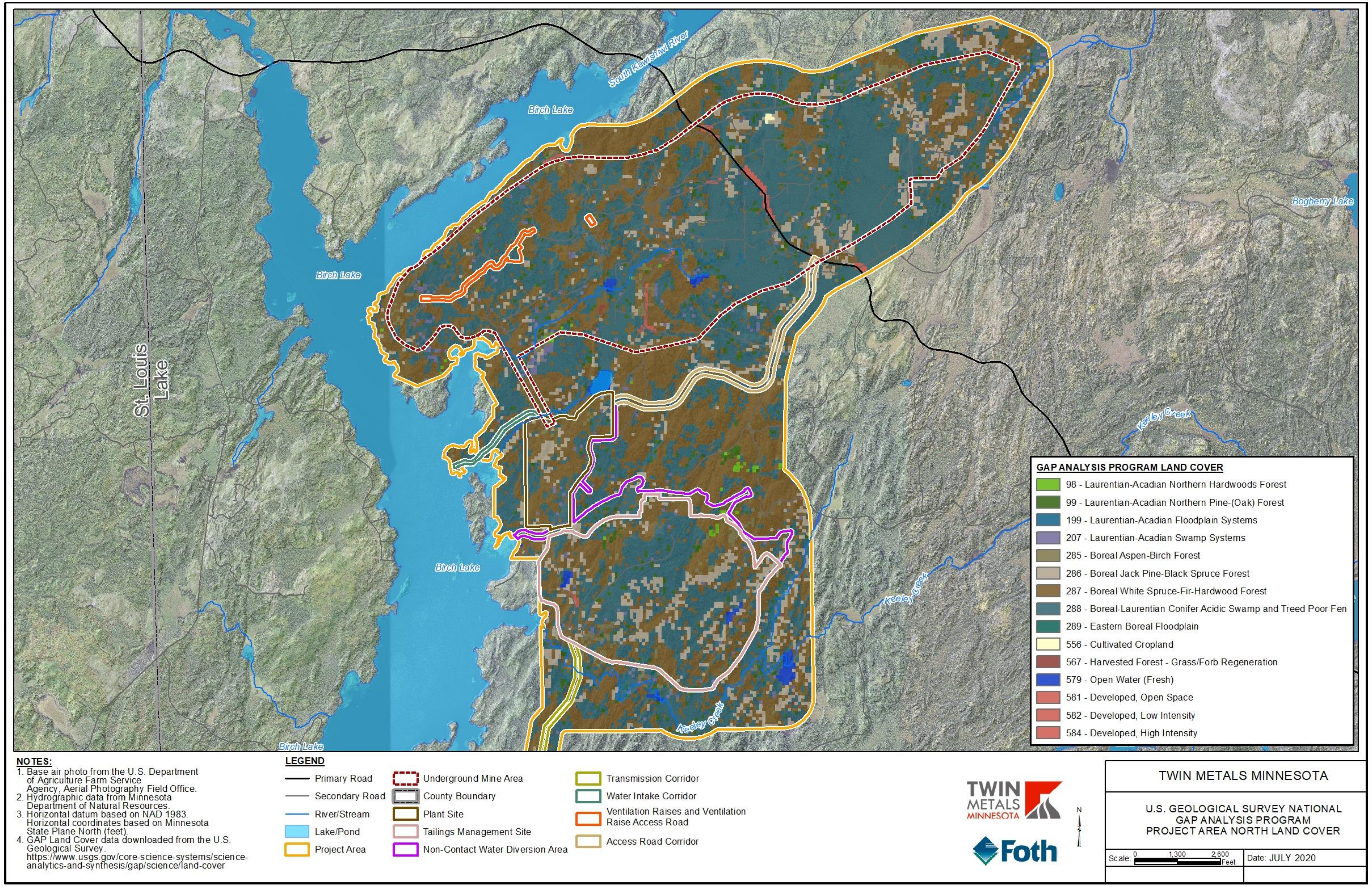


Figure 8-2 U.S. Geological Survey National Gap Analysis Program Project Area North Land Cover

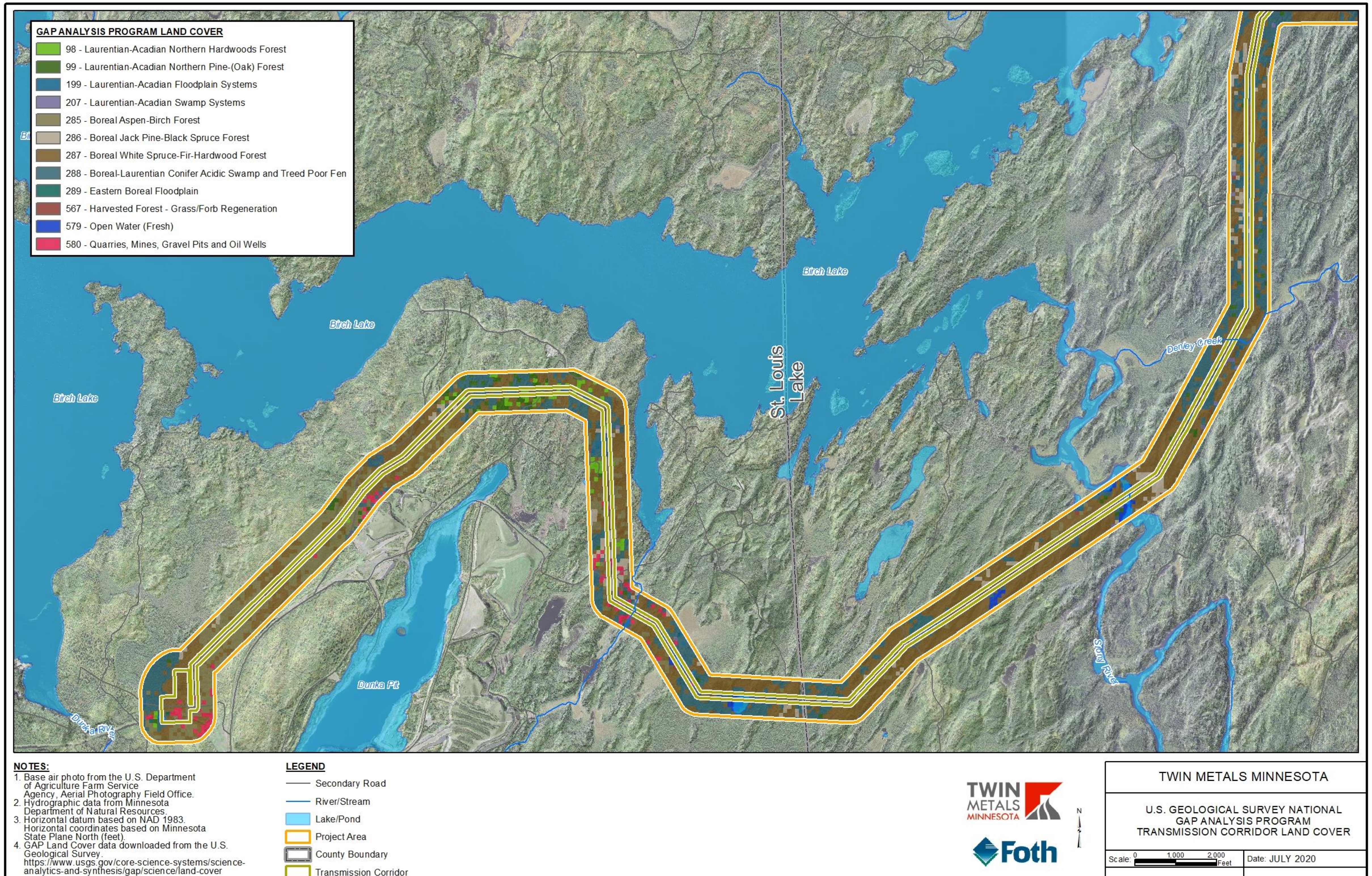


Figure 8-3 U.S. Geological Survey National Gap Analysis Program Transmission Corridor Land Cover

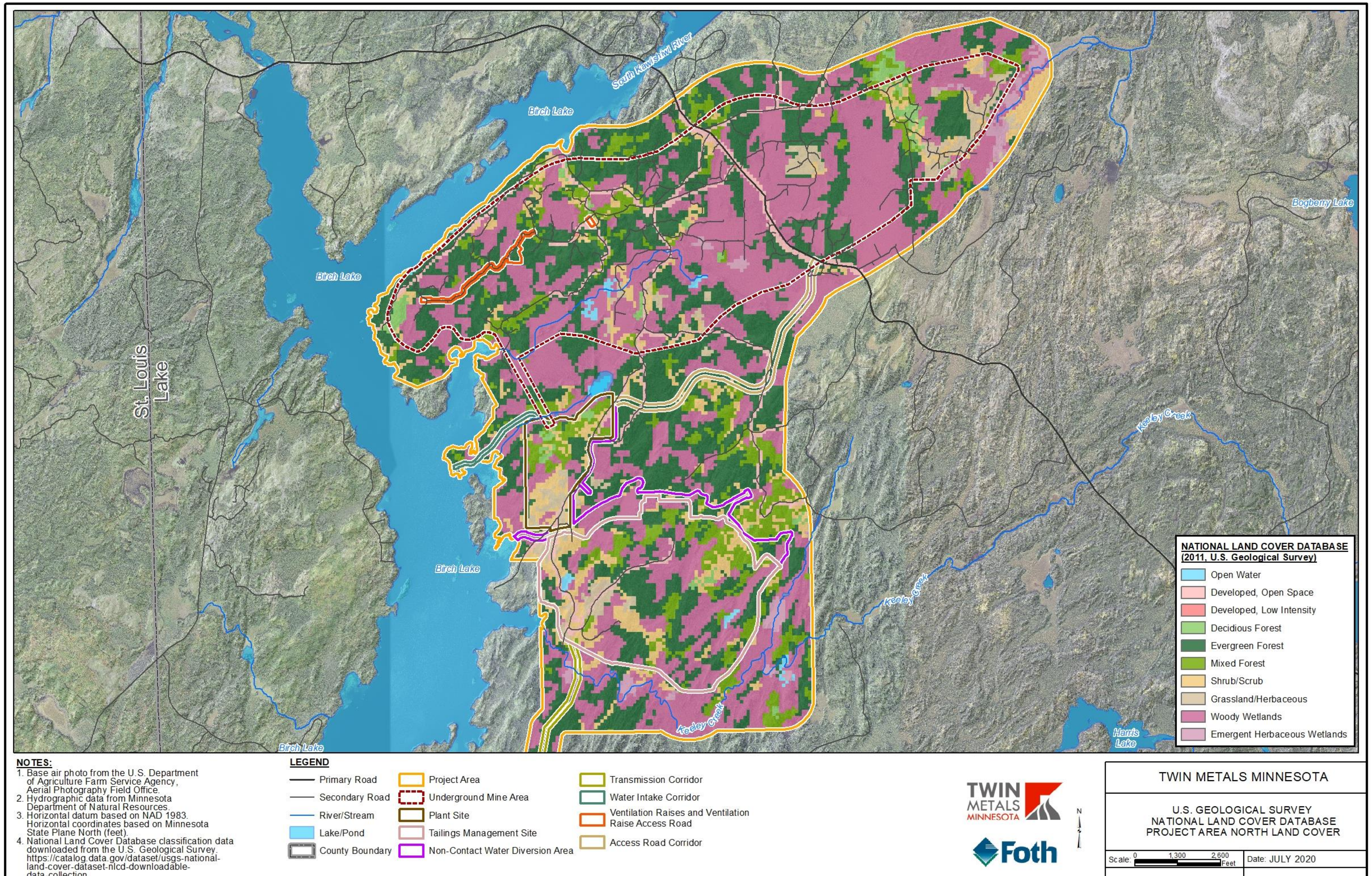


Figure 8-4 U.S. Geological Survey National Land Cover Database Project Area North Land Cover

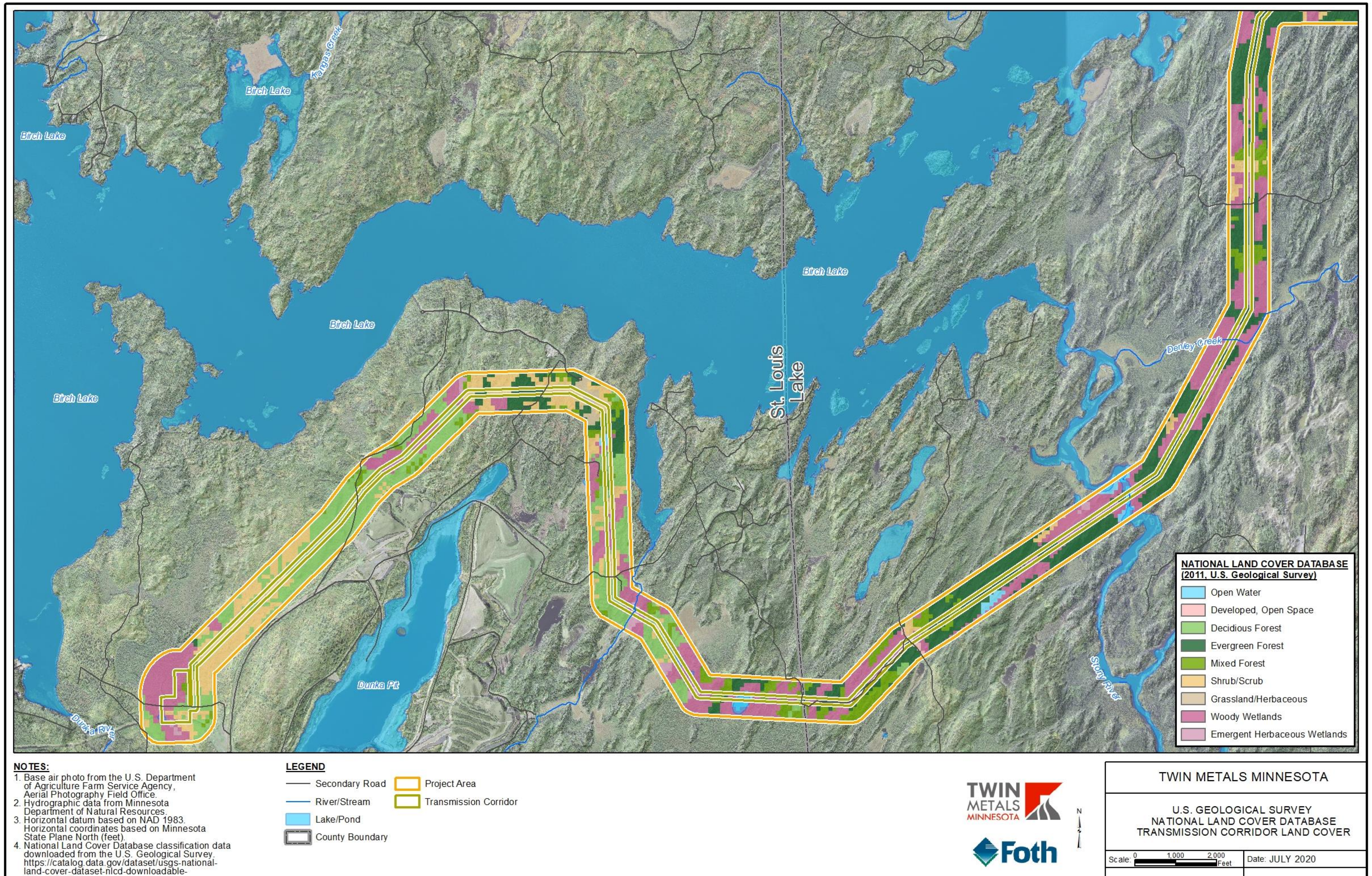


Figure 8-5 U.S. Geological Survey National Land Cover Database Transmission Corridor Land Cover

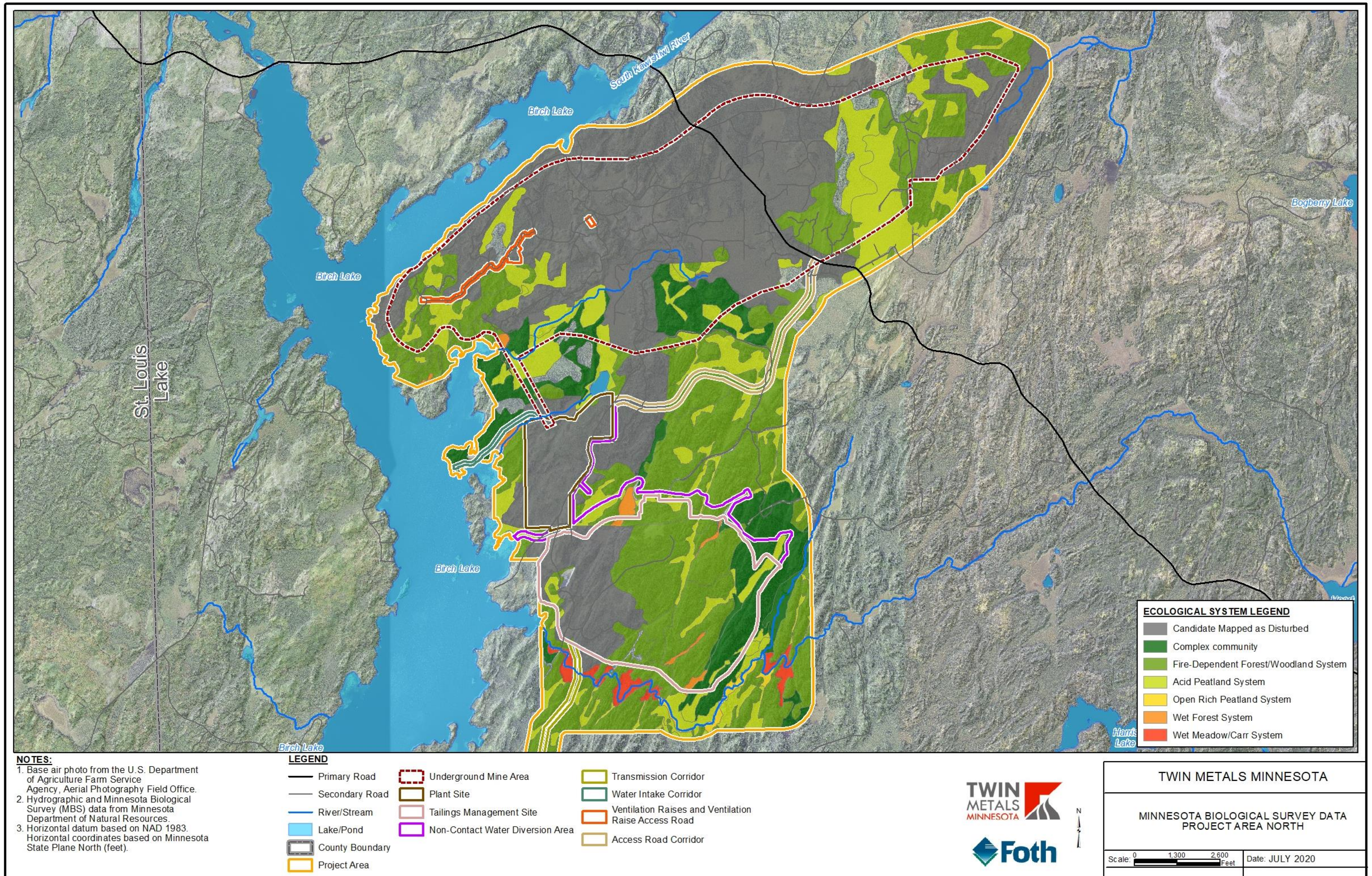


Figure 8-6 Minnesota Biological Survey Data Project Area North

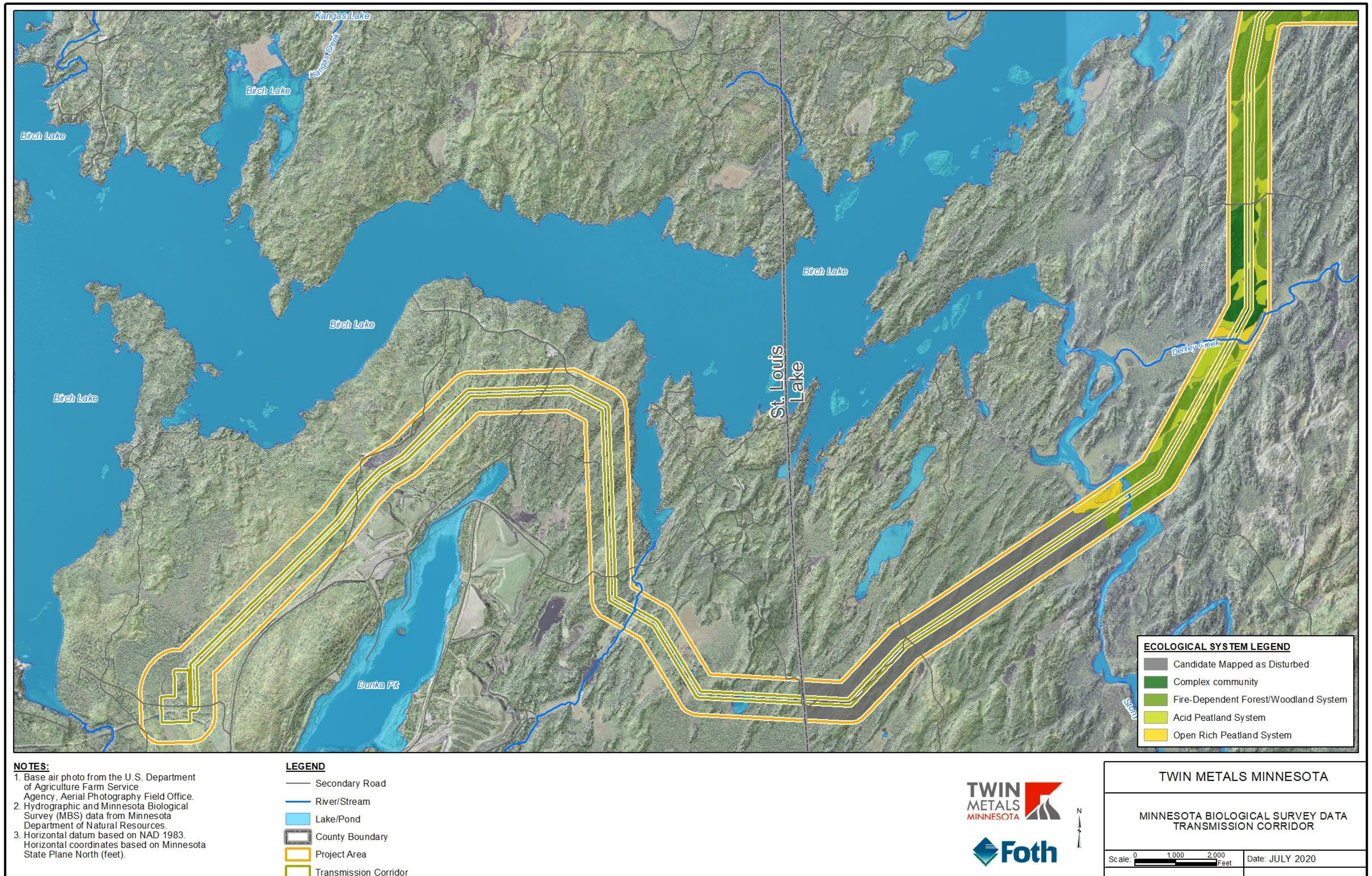


Figure 8-7 Minnesota Biological Survey Data Transmission Corridor

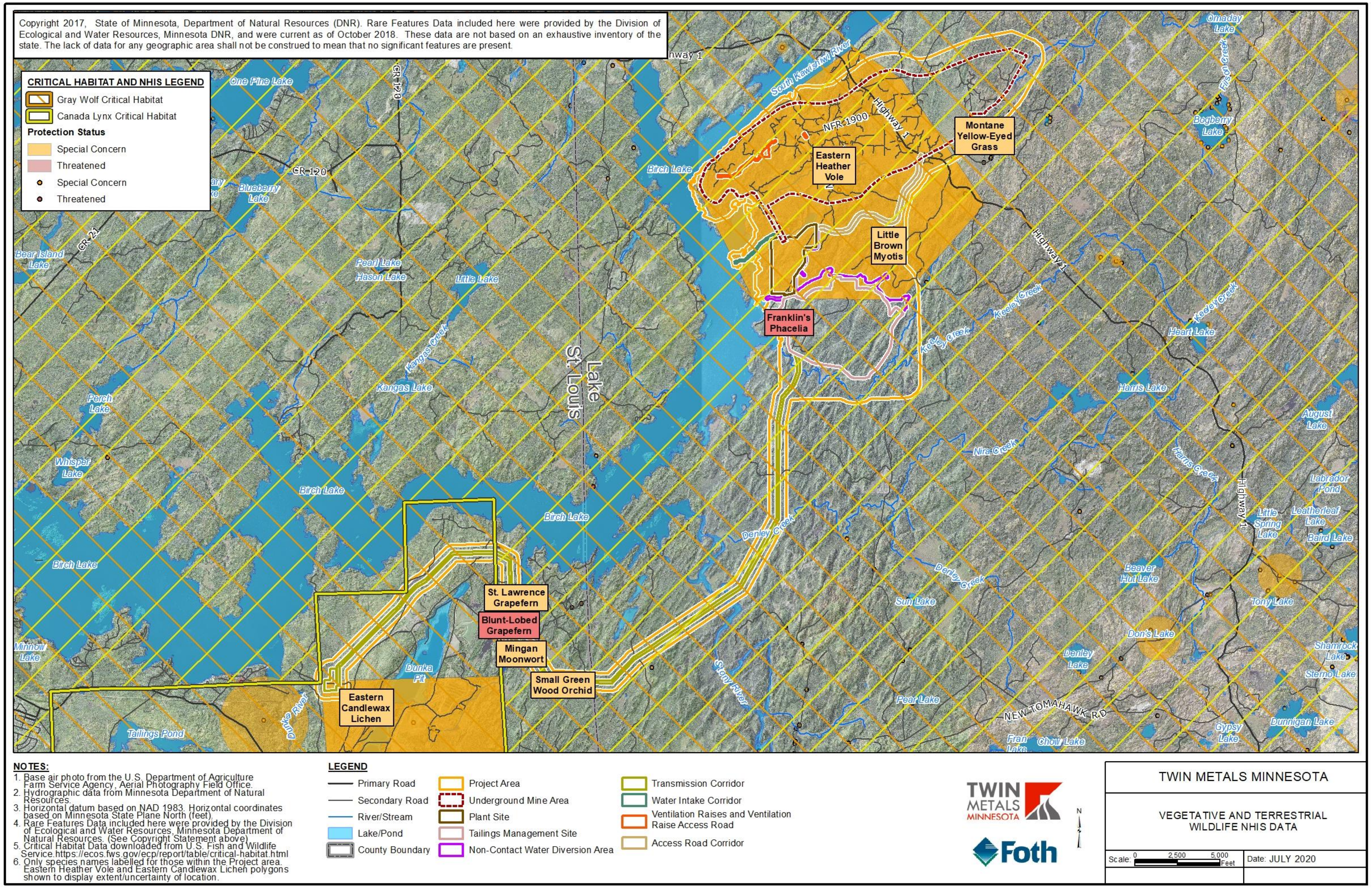


Figure 8-8 Vegetative and Terrestrial Wildlife NHIS Data

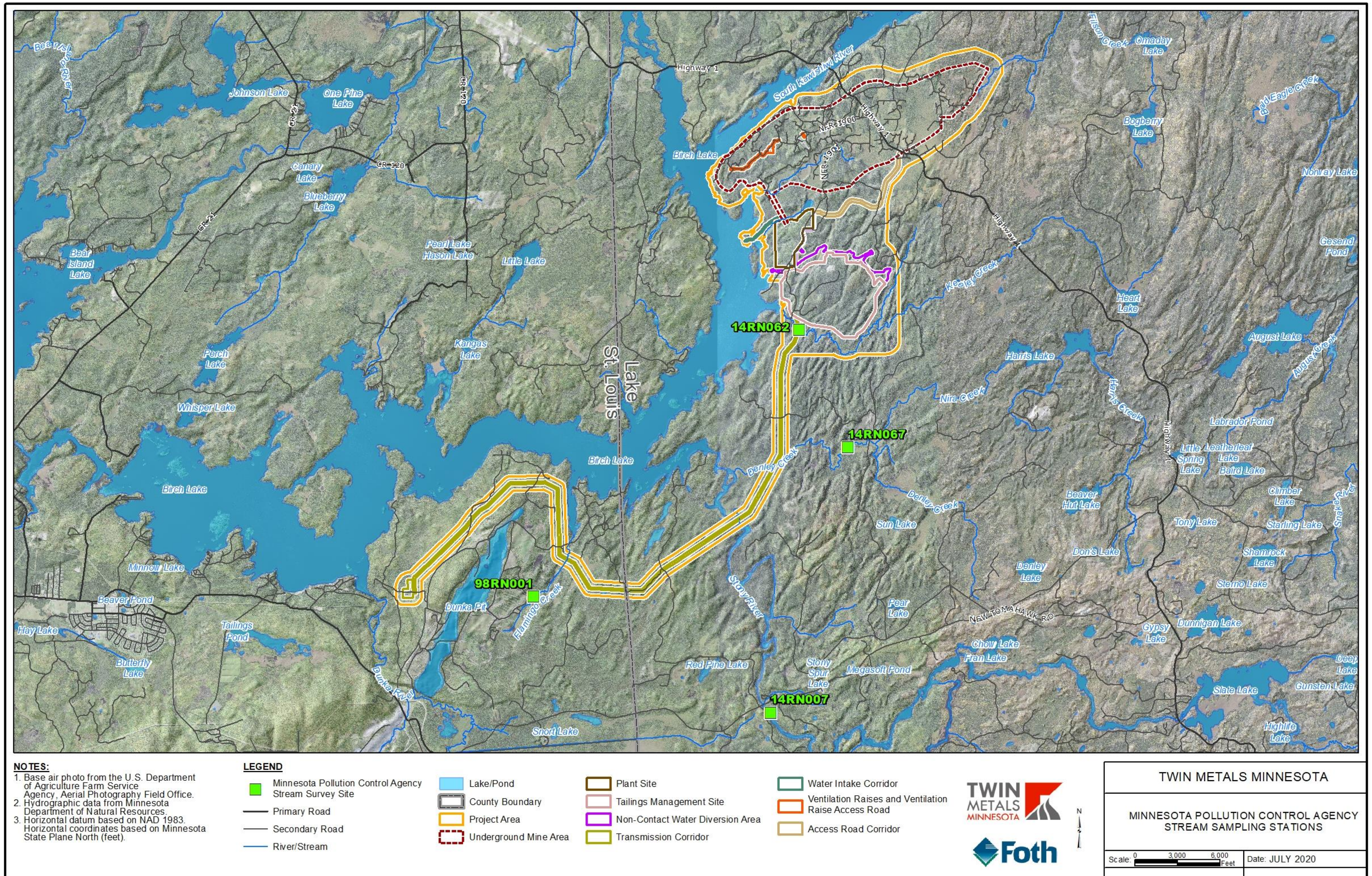
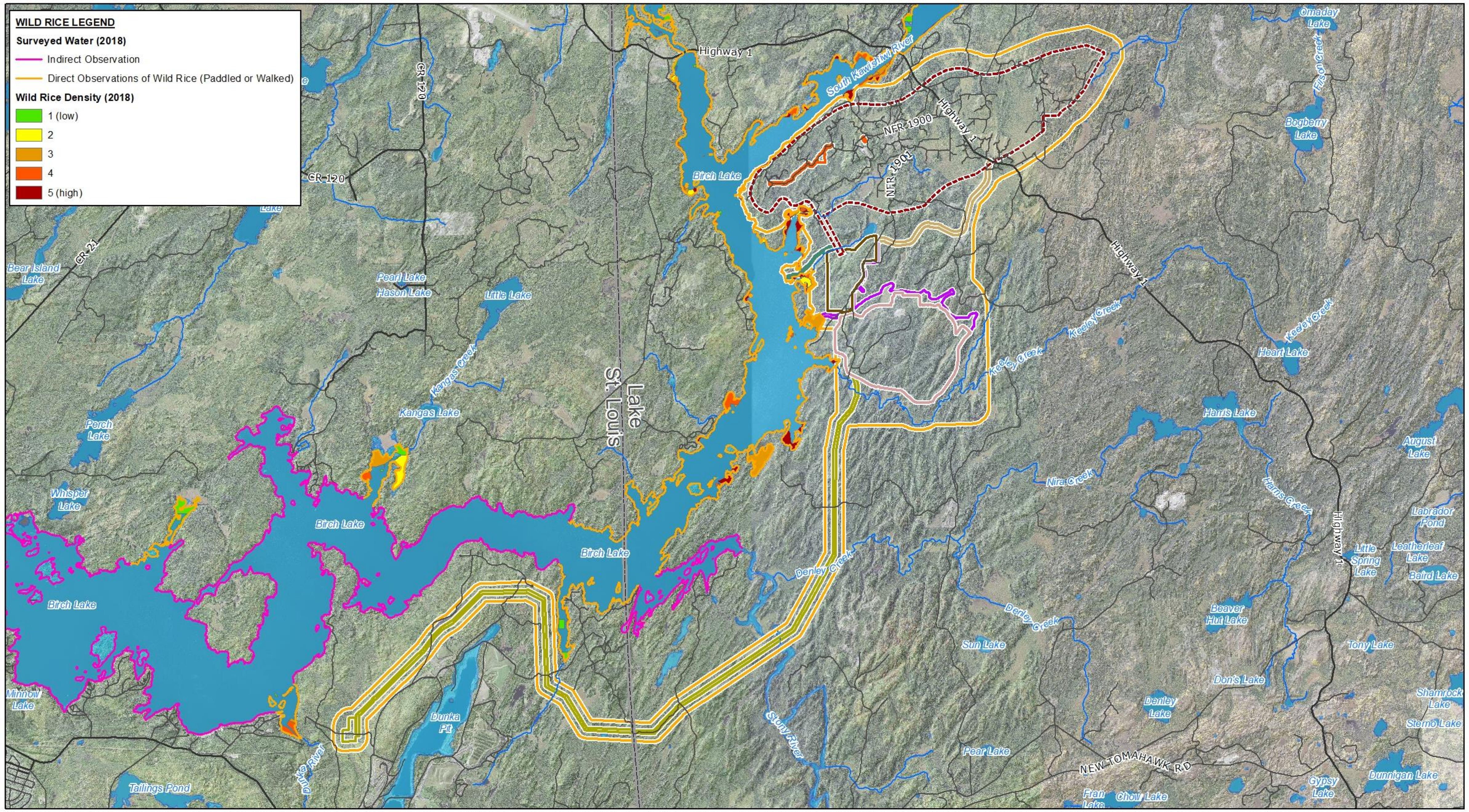


Figure 8-9 Minnesota Pollution Control Agency Stream Sampling Stations



NOTES:
1. Base air photo from the U.S. Department of AgricultureFarm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Wild rice survey data from Barr Engineering Co.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND
- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA
Foth

TWIN METALS MINNESOTA
WILD RICE SURVEYS
Scale: 0 2,500 5,000 Feet
Date: JULY 2020

Figure 8-10 Wild Rice Surveys

9.0 HISTORIC PROPERTIES AND CULTURAL RESOURCES

9.1 Baseline Conditions

In order to assess baseline historic, archaeological, and cultural resources, a review of archaeological surveys previously conducted within the Project area was completed. The results of this review inform ongoing Project planning and aid in compliance with state or federal cultural resources law, as applicable. The review used USFS files for the SNF and survey data on file at State Historic Preservation Office (SHPO) and Office of the State Archaeologist (OSA) as the primary sources of information. Table 9-1 provides a list of previous intensive archaeological reports within the Project area. The field investigations associated with these reports are summarized as follows:

- The Duluth Archaeology Center conducted a Phase I archaeological survey along TH 1 in 2003. No archaeological resources were identified within the Project area.
- In 2011, 10,000 Lakes Archaeology, Inc. conducted a Phase I for potential Project components in Lake and St. Louis Counties. No archaeological resources were identified.
- 106 Group conducted a Phase I archaeological survey for hydrogeologic field activities in 2012. No archaeological resources were identified.
- A Phase I survey of a portion of the Project area was completed by 106 Group in 2012. One new archaeological site and three potential cultural resources (PR) were documented. Of the three, PR #2 and PR #3 are identified as being located within the Project area.
- 106 Group completed a Phase I survey for hydrogeologic and exploratory drilling activities in 2013. No archaeological resources were identified.
- In 2016, 106 Group completed a Phase I survey associated with a potential access road route. No archaeological resources were identified.
- In 2017, portions of the Project area received a Phase IA visual assessment and Phase IB shovel testing. No archaeological resources were identified.
- 106 Group conducted a Phase I survey of hydrogeological well locations in 2018, a portion of which were in the Project area. One previously identified archaeological site was encountered.

Table 9-1 Previous Intensive Archaeological Surveys within the Project Area

Author	Year	Report Title
Duluth Archaeology Center	2003	Phase I Archaeological Survey on T.H. 1 (S.P. 3802-18), Lake County, Minnesota
10,000 Lakes Archaeology	2012	Phase I Archaeological Survey of the Potential Maturi, Nokomis, Birch Lake Shaft Sites for Twin Metals Minnesota Inc., Lake and St. Louis Counties, Minnesota
106 Group	2012b	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Federal Lands, Lake County, Minnesota
106 Group	2012c	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeologic Field Activities on Non-Federal Lands, St. Louis and Lake Counties, Minnesota
106 Group	2013a	Phase I Archaeological Survey for Potential Twin Metals Minnesota Areas of Interest, St. Louis and Lake Counties, Minnesota
106 Group	2013b	Phase I Archaeological Survey for Twin Metals Minnesota 1-A Expansion Drill Program, Lake County, Minnesota
106 Group	2013c	Phase I Archaeological Survey for Twin Metals Minnesota 1-A Expansion Drill Program, Lake County, Minnesota
106 Group	2016	Phase I Archaeological Survey for Twin Metals Minnesota Well MN-512 Access Road Reroute Project, Lake County, Minnesota
106 Group	2017	Cultural Resources Study/Survey 2017 Season for Twin Metals Minnesota, St. Louis and Lake Counties, Minnesota
106 Group	2018a	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Federal Lands, Lake County, Minnesota
106 Group	2018b	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Private Lands, St. Louis and Lake Counties, Minnesota
106 Group	2018c	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Non-Federal Public Lands, St. Louis and Lake Counties, Minnesota
106 Group	2018d	Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Federal Land, Lake County, Minnesota
106 Group	2019a	Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Private Land, St. Louis and Lake Counties, Minnesota
106 Group	2019b	Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Non-Federal Public Lands, Lake County, Minnesota

9.1.1 Archaeological Sites

Within the Project area, two archaeological sites have been previously identified. One of these sites, 21LA0568, has been field confirmed and the other, 05-006, has been reported, but not field confirmed.

Site 21LA0568 was recorded by SNF archaeologists in 1981. The site is characterized by metallic debris, cast iron stove parts, a bedspring, and a slag rock pile. Site 21LA0568 has not been evaluated for eligibility for listing in the National Register of Historic Places (NRHP). This location falls within the Project area.

Site 05-006 is an unconfirmed location of a settler’s cabin. The existence and precise location of this site have not been field-verified. This site has not been evaluated for eligibility for listing in the NRHP. This location falls within the Project area.

9.1.2 Historic Properties

In addition to the two previously identified archaeological sites, two architectural properties have been previously inventoried within the Project area: the Erie Mining Company Mining Landscape Historic District and a building listed as LA-FLK-005.

The Erie Mining Company Mining Landscape Historic District (XX-DST-004) has been previously determined to be eligible for listing in the NRHP. The boundary for this district is not clearly defined and additional survey work not associated with the Project is being completed to more clearly define the boundary and contributing properties. Preliminary information identifies that the potential boundaries of the district, and at least one contributing property (Dunka Road, SL-ROD-004), overlap with a portion of the Project area.

LA-FLK-005 is a building within the Project area that has been previously inventoried but has not been evaluated for listing in the NRHP.

9.1.3 Cultural Resources

Two PR have been identified within the Project area during previous survey work or work associated with other projects. These two PR have not been formally recorded as archaeological sites or historical properties by SHPO, OSA, or SNF. These sites are identified as PR #2 and PR #3. In addition to these sites, the Mesabe Widjiu is potentially in the vicinity of the Project area but the exact geographic extent is not known.

PR #2 is identified as a pictograph of a geometric form in red pigment located on a large glacial erratic; this site was identified in 2013. Site visits with the Bois Forte Band of Chippewa elders indicate that this resource may have potential significance to Native Americans.

PR #3 is a semicircular stone arrangement associated with a rectangular depression; this site was identified in 2013. The origin and function, or potential significance to Native Americans, are unknown. Shovel tests excavated around the feature were negative, and no charcoal was observed.

Mesabe Widjiu, or the Laurentian Divide, is of cultural importance to Ojibwe tribes. This natural feature is a line of Precambrian hills that separates watersheds flowing north to the Arctic Ocean from those flowing south to the Great Lakes. The exact geographic extent of the Mesabe Widjiu and its proximity to the Project area are unknown.

9.2 Project Impacts

The review of previous historic and cultural investigations indicate there are recorded and potential resources within the Project area; however, all of the recorded and potential resources which have clearly defined limits fall outside of the construction limits for the Project. As a result, there are no anticipated impacts to recorded and potential historic or cultural resources which have been identified.

9.2.1 Archaeological Sites

While identified archaeological sites 21LA0568 and 05-006 are within the Project area, they are not within the construction limits of any Project features and there are no anticipated impacts to these archaeological sites.

9.2.2 Historic Properties

The Erie Mining Company Mining Landscape Historic District overlaps small portions of the transmission corridor, however, the limits of construction for the transmission corridor and off-site electrical substation are outside of the anticipated boundaries for this district. There are no anticipated impacts to this historic district.

LA-FLK-005 would be located within the Project area but this resource is not located within the construction limits of any features associated with the Project. There is no anticipated need to disturb LA-FLK-005.

9.2.3 Cultural Resources

The alignment of the access road to the plant site was adjusted to avoid potential impacts to PR #2. No impacts are anticipated to this potential resource.

PR #3 is located within the Project area but is not located within the construction limits of the transmission corridor; therefore, no impacts are anticipated to this potential cultural resource.

The geographical extent of the Mesabe Widjiu is currently not known; therefore, coordination with tribal representatives regarding potential Project impacts is anticipated.

9.2.4 Archaeological Sites, Historic Properties and Cultural Resources Impacts Summary

Available information to fully assess potential Project impacts to archaeological sites, historic properties, and cultural resources is insufficient but could be reasonably obtained. Available information indicates no potential impacts would occur, but additional work is needed to determine whether previously unidentified sites exist in the Project area. Potential impacts are preliminarily characterized in the following manner:

- Archaeological sites, historic properties, and cultural resources which have been identified during previous investigations all fall outside of the construction limits of any features associated with the Project. As a result, there are no anticipated impacts for areas of the Project that have been previously investigated.
- In portions of the Project area where no previous investigation has occurred, there is insufficient information to assess the potential for impacts to archaeological sites, historic properties, and cultural resources but this information could be reasonably obtained. In order to fully assess the potential impacts to historic and cultural resources, areas of planned soil

disturbing activities, which have not previously been investigated, would need to be investigated.

Future work to assess potential impacts to archaeological sites, historic properties, and cultural resources in portions of the Project area where no previous investigation has occurred is outlined in Section 9.3.

9.3 Future Scope

The purpose of the following scope of work is to identify additional historic or cultural resources existing within the Project area. The extent of the investigation area will be limited to the tailings management site, plant site, underground mine area, water intake corridor, access road, and transmission corridor where soil disturbing activities are anticipated to occur and where no previous investigations have occurred. Areas considered to have low potential for containing archaeological resources include disturbed or inundated areas, former or existing wetlands areas, poorly drained areas, and areas with slopes of >20°. Areas assessed as possessing low potential will not be investigated further.

9.3.1 Cultural Resources

Prior to cultural resource surveys being completed, TMM will notify and coordinate with the Bois Fort Band of Chippewa, the Grand Portage Band of Lake Superior Chippewa, the Fond du Lac Band of Lake Superior Chippewa, and other tribes as directed to develop an approach that considers Native American perspectives. TMM will work with tribes to coordinate field survey work and maintain a high degree of communication throughout the cultural resources survey work.

9.3.2 Historic Properties and Archaeological Resources

The approach used to identify these resources will utilize methods used during previous investigations associated with the Project. These methods were developed in accordance with *SHPO Manual for Archaeological Projects in Minnesota* (Anfinson, 2005); the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* (48 Federal Register 44716-44740; National Park Service, 1983); and all required permits, including Special Use Permits issued by the USFS pursuant to the Archaeological Resources Protection Act of 1979 for surveys on federally-owned lands and Minnesota Archaeological Survey Licenses issued by the OSA for surveys on non-federal public lands.

The Phase I archaeological survey will be divided into two components: Phase IA visual assessment, and Phase IB survey (pedestrian survey or shovel testing).

9.3.2.1 Phase IA Visual Assessment

Visual reconnaissance will be employed to ascertain whether aboveground historic or cultural features were present within survey areas, to assess whether portions of survey areas have been extensively disturbed, and to assess survey areas for archaeological potential. Areas having a moderate to high potential of containing intact archaeological resources will then be subject to Phase IB.

Areas considered to have a moderate to high potential of potentially containing intact archaeological resources generally include undisturbed areas that are:

- Located within 500 ft (150 m) of an existing or former water source of 40 acres (19 ha) or greater in extent, or within 500 ft (150 m) of a former or existing perennial stream;
- Located on topographically prominent landscape features;
- Located within 300 ft (100 m) of a previously reported or recorded archaeological site; or
- Located within 300 ft (100 m) of a former or existing historical structure feature (such as a building foundation or cellar depression).

9.3.2.2 Phase IB survey

A systematic pedestrian survey will be conducted in portions of survey areas identified during visual assessment as possessing moderate to high potential to contain intact archaeological resources, and where >25% of the ground surface was visible. Systematic pedestrian survey will generally be conducted in 50-ft (15 m) intervals.

Shovel tests will be conducted in portions of survey areas identified during visual assessment as possessing moderate to high potential to contain intact archaeological resources, and where <25% of the ground surface was visible. Shovel tests will be small, circular excavations, measuring approximately 14 to 16 inches (35 to 45 cm) in diameter. All excavated soil matrices will be passed through ¼-inch hardware mesh to ensure the consistent recovery of artifacts. Tests will be distributed at 50-ft (15 m) intervals, as allowed by the natural and topographic characteristics of the area. According to the professional judgment of the field director and crew leaders, transects will be sometimes narrowed to 15 ft (5 m) or 30 ft (10 m) in areas assessed as having higher potential for pre-contact archaeological sites, such as terraces adjacent to rivers or lakes. Transects will be occasionally widened in areas where landscape features, such as slope or bedrock outcrops, prohibited regular transects. Shovel tests will be excavated down to the level of archaeologically sterile subsoil or until an impasse was reached.

Survey data will be recorded through standardized forms and the field director's daily log. Recorded information included observations on field conditions and surface visibility; shovel test locations; the depth of shovel tests; the thickness of excavated soil layers; soil textures and inclusions (both natural and cultural); and soil color according to Munsell color charts.

The deliverable from a Phase I archaeological survey will be a report summarizing findings from the survey. This report will identify additional potential historic resources within the Project area where soil disturbing activities were planned to occur and help further inform the level of potential impact associated with the Project.

10.0 VISUAL

10.1 Baseline Conditions

10.1.1 Viewshed

Within the Project area, the viewshed from the ground is predominantly tree cover with open areas created by timber harvest and dimension stone mining activities. Viewshed openings within a half mile of the plant site or tailings management site occur along the forest road network, from commercial logging activities, or around and on Birch Lake. Birch Lake is characterized by a viewshed similar to those commonly found on lakes in northern Minnesota of forested shoreline, residential buildings, seasonal cabins, campgrounds, resorts, and rural roads. At the nearest point, the Project area is approximately five miles from the southwestern border of the BWCAW, an area characterized by viewsheds of undeveloped upland forests, open water, and wetlands relatively free from the sights and sounds of human activity. Approximately the same distance to the southwest the viewshed includes active iron mining operations and land uses consistent with iron mining activities and ongoing reclamation. The predominant land cover within a five mile radius is forested and the viewshed within that radius is dominated by tree cover. The regional terrain reflects historic glaciation and is marked by rolling to hilly areas interspersed with wet lowland depressional areas. Within a mile of the Project area, topographic relief can vary as much as approximately 200 ft (61 m).

10.2 Project Impacts

Project-related potential visual impacts include:

- Infrastructure visibility;
- Light visibility at night; and
- Potential visibility of plumes (discussed in Section 10.3).

The potential visual impacts associated with the Project are assessed in the context of the desired scenic resource conditions outlined in the SNF Land and Resource Management Plan (USFS, 2004). Within this plan, the location of the Project area is identified as having moderate and high scenic integrity objectives. The plan further characterizes the Project location as primarily General Forest, with a minor amount of the Project area designated Recreation Use in a Scenic Environment. The desired scenic resource condition for these land designations are as follows:

10.2.1 General Forest

The forest has a fairly continuous canopy and frequent openings of various sizes up to 1,000 acres (404.7 ha). The openings' size, shapes, and habitat conditions, not necessarily their appearance, mimic the scale, pattern, and ecological function of large-scale natural disturbances. In the most frequently visited and most scenically valued areas of this management area, the large-scale openings have a natural appearance. Other, less scenic areas of this management area will be actively managed for timber production with a lower relative emphasis on scenery compared to other resource concerns.

10.2.2 Recreation Use in a Scenic Environment

Viewsheds are managed for scenic beauty and big-tree character. Generally, this management area offers natural-looking forest surroundings with some facility and trail development and roads for recreation. SNF management enhances recreation and scenic objectives and management activities may be noticeable to visitors. Visitors to the SNF may occasionally see management activities such as timber harvest, management-ignited fire, tree planting, and other resource management techniques.

10.2.3 Visual Simulation

A visual simulation is the graphic representation of the Project that is created to help visualize a potential change to the landscape. In this case, a view looking east from Birch Lake was chosen as the existing condition and Project infrastructure was imposed into the landscape to simulate the scale of the Project at the end of the 25-year operational life in an unreclaimed state (Figure 10-1). Concurrent reclamation would begin with the portion of the dry stack facility facing Birch Lake and be ongoing during the operational life of the Project.

In order to create the visual simulation, aerial panoramas were collected during winter using a DJI brand quadcopter from the western side of Birch Lake. Based on local topography and tree cover, this location on Birch Lake was selected as the most likely to demonstrate visual impacts from Project infrastructure. From the location on Birch Lake, the quadcopter hovered 30 ft (9.1 m) above lake level where 12 to 34 overlapping images were taken. Overlapping images were then edited and stitched together to create a final panorama to be used in the simulation.

Publicly available LiDAR was used to create the bare earth surface. Tree canopy height was created using classified vegetation points within the publicly available LiDAR. The bare earth and tree canopy surfaces were then imported into Civil 3D and combined with a 3D model of Project infrastructure within Civil View.

The visual simulation indicated that the top of the secondary ore stockpile, the top of the primary ore stockpile, the rooftop of the concentrator, and a portion of the dry stack facility are likely to be visible from the location selected on Birch Lake.

10.2.4 Viewshed Analysis

In addition to the visual simulation from Birch Lake, a preliminary “direct line of sight” viewshed analysis was completed to identify Project impacts on a regional scale (>1 mile [1.6 km]). A “direct line of sight” viewshed analysis evaluates whether there is a direct line of sight between two points on a map by analyzing the elevation of both objects and incorporating existing landmarks that may obstruct the line of sight.

The preliminary viewshed analysis assessed the visibility of the dry stack facility at the end of operations. This Project feature, the dry stack facility, was chosen as it would eventually be the tallest point of Project infrastructure, averaging 130 ft (40 m). Emissions from the plant site and / or ventilation raises may also be visible under specific climatic conditions, but not consistently present. In addition, fugitive dust from small areas of the dry stack facility may be intermittently visible. The analysis focused on identifying areas where a direct line of site to the dry stack facility may be possible from key points of interest (POI). POI accessible to the public were assessed both within the BWCAW (lakes, rivers, campsites, portages, and designated hiking trails) and outside of the BWCAW (TH 1, Ely airport).

In order to narrow down the number of POI that may have a direct line of site to the dry stack facility, the viewshed analysis first assessed which POI may be visible from the perimeter of the crest of the dry stack facility, assuming no tree cover was present. This evaluation was then compared to a more representative assessment, which looked at POI potentially visible from the perimeter of the crest of the dry stack facility assuming tree cover was present; tree height was estimated based on the difference between ground and vegetation surfaces in LiDAR data. The two assessments were compared and used to identify seven POI where the likelihood of having a direct line of site to the dry stack facility was highest; three POI were identified in the BWCAW, three POI located along TH 1, and one POI located at the Ely airport shown on Figure 10-2. The three POI selected within the BWCAW were the POI with the highest likelihood of having a direct line of site to the dry stack facility.

An evaluation of each POI was then conducted to analyze whether a direct line of sight to the dry stack facility existed. This evaluation assessed the viewshed from each POI looking towards the dry stack facility assuming the viewpoint to be fixed at 6 ft aboveground level and conservatively applying a condition of no tree cover for the first 1,000 ft (304.8 m).

The viewshed analysis indicated one POI (DSF-C3) located along TH 1 may have a direct line of sight to the dry stack facility, as shown in the cross section displayed on Figure 10-3. This potential line of sight is not anticipated to be unobstructed, as tree cover would likely interfere with visibility. Additionally, Figure 10-3 represents the scale of the dry stack facility at full development after 25 years of operation. It is anticipated that concurrent reclamation and revegetation of the dry stack facility during this operational life would limit this potential visibility. Additional locations along TH 1 may have a direct line of site to the dry stack facility depending on tree cover and elevation.

The three POI within the BWCAW that were assessed (DSF-A, B, D) are not anticipated to have a direct line of sight with the dry stack facility. The direct line of sight for these locations is anticipated to be obstructed by topography or tree cover.

10.2.5 Light Visibility

The Project included recommendations from International Dark-Sky Association (IDA, 2019), a recognized authority on light visibility whose mission it is to preserve dark skies through environmentally responsible outdoor lighting practices. As such, the International Dark Sky Association has developed a list of best design practices that reduce light visibility. Potential sources of light visibility associated with the Project would include but would not be limited to, vehicle traffic around the plant site and tailings management site, safety lighting for walkways or driving corridors, and entry / exit lighting for Project infrastructure.

Mining would occur underground, thereby limiting surficial visual impacts to Project infrastructure. Surficial Project infrastructure was designed to minimize impact through the following practices:

- The primary ore stockpile would be designed to minimize the height of its geodesic dome cover.
- The concentrator would be designed to reduce the overall height of process buildings.
- The mine would be designed to be accessed through a decline, thereby eliminating the need for a mine shaft and hoist derrick.
- The design of the Project would allow for no waste rock stockpiles.
- The temporary rock storage facility and reclamation material stockpiles would be sized to reduce overall height.
- Buildings would be painted, stained, and / or treated to produce flat-toned, non-reflective surfaces.
- Building color would be selected to blend into the surrounding environment.
- Revegetation of the dry stack facility would be designed to be ongoing during operations beginning with the dry stack facility face closest to Birch Lake.
- The water intake infrastructure would be designed to be screened from Birch Lake.

The following standards have been included in the Project design to reduce light pollution where practicable:

- Project lighting, where practicable, would be located to avoid light visibility. All light fixtures would be hooded and shielded, located within soffits, and faced downward or directed toward the operating areas. Light fixtures would incorporate shields and / or louvers where possible and be full cut-off type.
- The use of dimmers, timers, and motion sensors would be installed where appropriate.
- Lighting would be no brighter than necessary.
- Blue light emissions would be minimized.
- Fugitive dust would be minimized in order to reduce “sky glow” by reducing the light reflectance from dust particles.
- Lighting would be removed during reclamation and post-closure maintenance and monitoring phases unless a future use is identified and approved.

10.2.6 Visual Impacts Summary

The available information is adequate to make a reasoned decision about the potential for, and significance of, Project visual impacts. The potential visual impacts identified by the visualization, viewshed analysis, and lighting are characterized in the following manner:

- Temporary / Permanent – The visual impacts and lighting from buildings would be temporary, as these buildings would be removed during reclamation. The visual impacts associated with the dry stack facility would be permanent. The dry stack facility would be reclaimed to become part of the natural landscape and would resemble local topographic relief.

- Reversibility – Grading and revegetation of the dry stack facility would serve to partially reverse impacts associated with construction of the dry stack facility.
- Extent – The extent of potential visual impacts would be limited to portions of Birch Lake western shoreline areas, and potentially intermittent segments from TH 1 depending on tree cover. The visual simulation indicated that the top of the secondary ore stockpile, the top of the primary ore stockpile, the rooftop of the concentrator, and a portion of the dry stack facility are likely to be visible from the POI location selected on Birch Lake. The magnitude of this impact would be comparable to local topographic relief which can vary up to 200 ft (61 m) within one mile of the Project area. Additionally, the level of visibility expected to result from the Project corresponds to expected scenic resource conditions identified for the SNF.

Based on the impact reduction measures incorporated into Project design and the desired scenic resource conditions identified by the SNF Land and Resource Management Plan, visual impacts are minor.

10.3 Future Scope

No future scope of work exclusive to visual impacts is proposed. Future work described in Section 11.3 will inform assessment of potential visual impacts related to plumes.

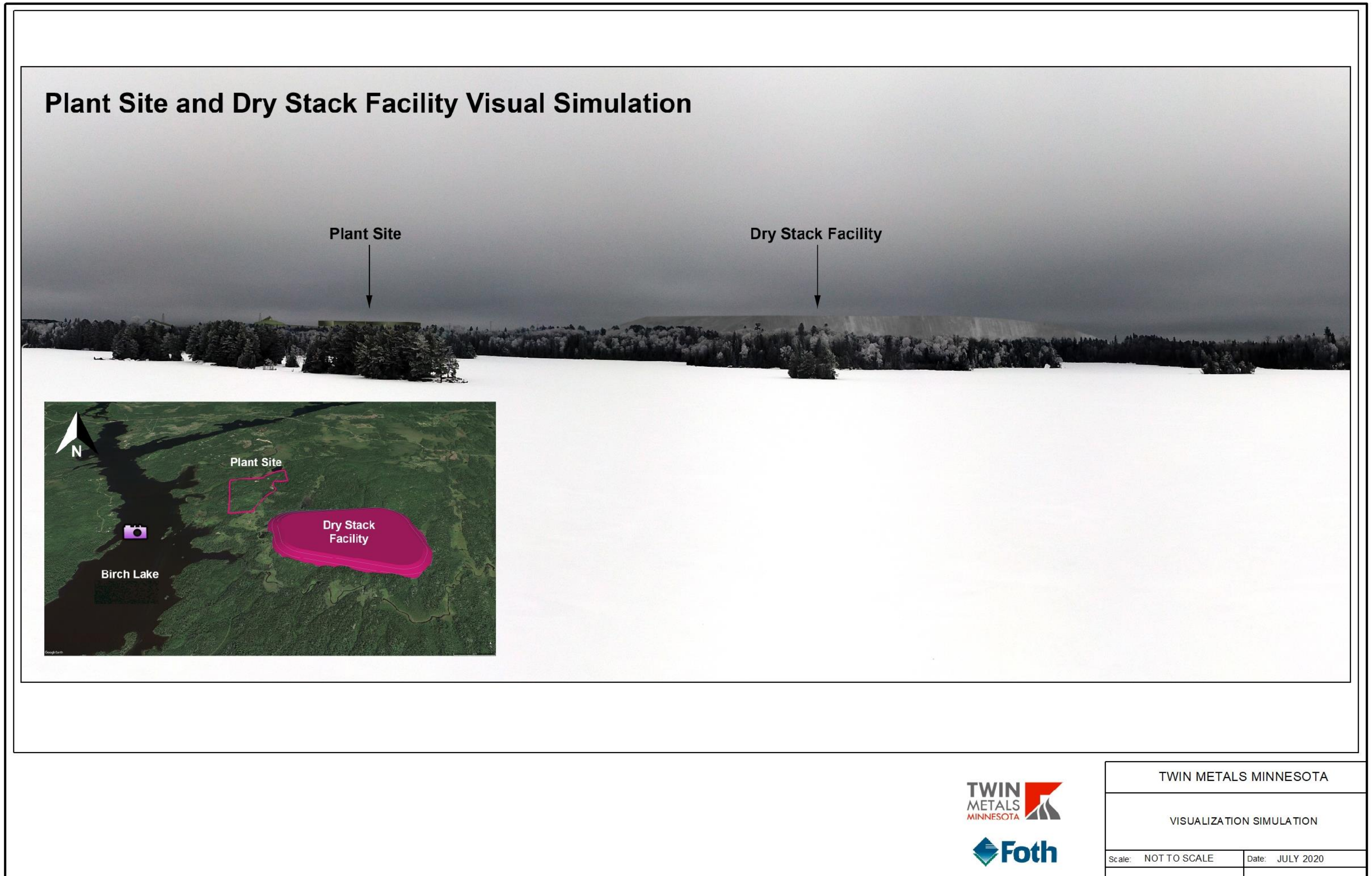
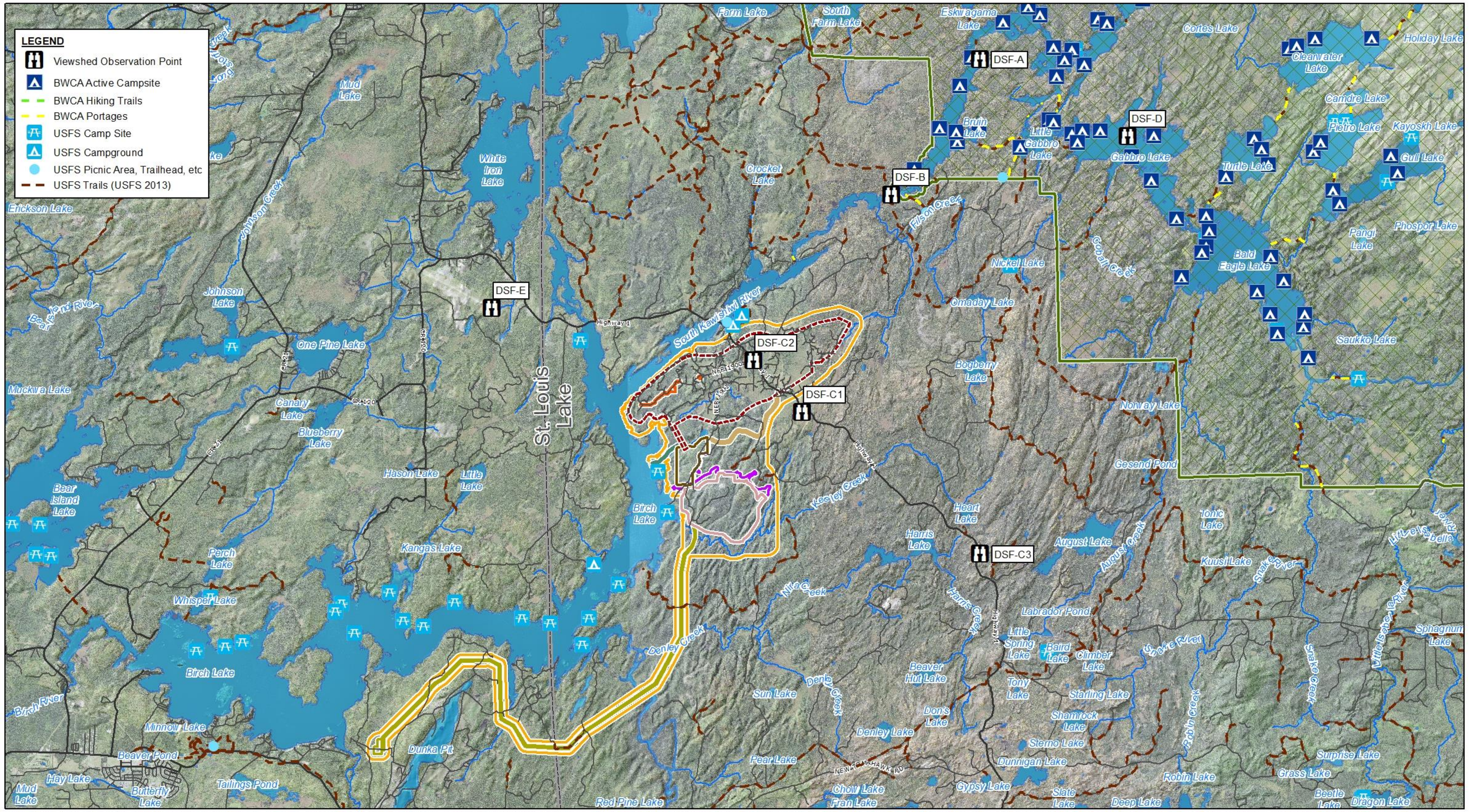


Figure 10-1 Visual Simulation



NOTES:
1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Top of dry stack facility simulated at elevation 1,617.5 feet.

LEGEND
- River/Stream
- Lake/Pond
- Boundary Waters Canoe Area Wilderness
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

VIEWSHED ANALYSIS LOCATIONS

Scale: 0 4,000 8,000 Feet | Date: JULY 2020

Figure 10-2 Viewshed Analysis Locations

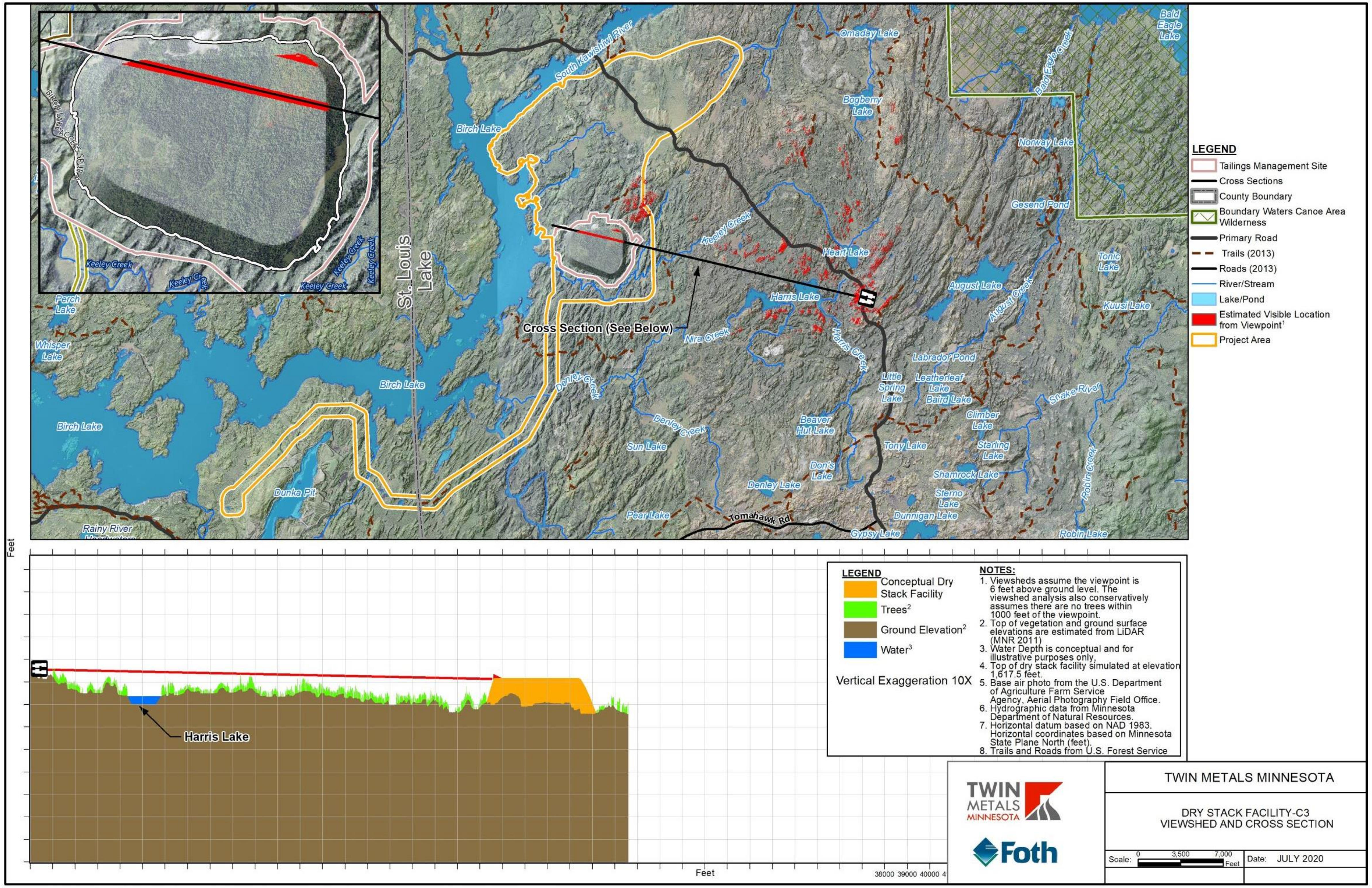


Figure 10-3 Dry Stack Facility-C3 Viewshed and Cross Section

11.0 AIR

11.1 Baseline Conditions

11.1.1 Air Quality

Historically, air quality impacts to this location have been limited to impacts derived from emission sources associated with logging, mineral exploration, and OHV recreation.

In order to assess the baseline ambient conditions in the vicinity of the Project, a review of publicly available data was conducted. The MPCA has ambient monitoring data available for monitoring stations throughout the state and provides air modeling design values for projects in these locations. The current design values are based on data for the most recent full monitoring years of 2015, 2016, and 2017. These design values include specific values for different size fractions of particulate matter (PM), specifically $PM_{2.5}$ and PM_{10}. The 24-hour $PM_{2.5}$ and annual $PM_{2.5}$ ambient background concentrations were acquired from the Ely, Minnesota (Station No. 0005) location, which is relatively close to the Project area. The 24-hour PM_{10} concentrations were obtained from Silver Bay (Station No. 7640-1), near the North Shore process plant site. While this site is located along Lake Superior, this is the closest site that has ambient background concentrations processed for PM_{10}. Given these air monitoring stations are both in the general vicinity of the Project area, they are considered to be representative of background concentrations.

The ambient background levels for 1-hour and annual nitrogen dioxide (NO_2); 24-hr, 3-hour, 1-hour, and annual sulfur dioxide (SO_2); and 1-hour carbon monoxide (CO), and 8-hour CO were determined using data from Rosemount (Station No. 0423) near Minneapolis as the most representative location. This site was used because there are no recent design values available for these gaseous pollutants in northern Minnesota. This monitoring site is also located away from major roadways, so it is considered to be the most representative monitoring location for background conditions in rural northern Minnesota.

Background concentrations are shown in Table 11-1.

A wind rose has been included in Figure 11-1. The wind rose shows prevailing wind directions, based on data from Hibbing, Minnesota (Station #94931), are generally from a northwesterly direction. Maximum wind speeds are associated with northwesterly wind directions and the average wind speed for the period of record (01-01-2012 through 12-31-2016) was 7.5 miles per hour (3.37 meters per second).

Table 11-1 Background Criteria Pollutant Concentrations

Criteria Pollutant	Averaging Period	Meteorological Data Year	Background Concentration[1] ($\mu g/m^3$)
$PM_{2.5}$	Annual	2012-2016	4.0
$PM_{2.5}$	24-Hr Avg	2012-2016	12
PM_{10}	24-Hr Avg	2012-2016	70
SO_2	Annual	2012-2016	1.6
SO_2	24-Hr Avg	2012-2016	3.7
SO_2	3-Hr Avg	2012-2016	7.8
SO_2	1-Hr Avg	2012-2016	10.5
NO_2	Annual	2012-2016	5.6
NO_2	1-Hr Avg	2012-2016	45
CO	8-Hr Avg	2012-2016	600
CO	1-Hr Avg	2012-2016	800

Notes:

[1] Background ambient air concentrations are calculated design values based on data provided by the Minnesota Pollution Control Agency (MPCA) through its Criteria Pollutant Data Explorer website. $PM_{2.5}$ data were obtained from Ely, Minnesota (0005). Using MPCA guidance for calculation of background concentrations, the $PM_{2.5}$ 24-hour background concentration is the average of the 98th percentile 24-hour values over three years. The $PM_{2.5}$ annual background concentration is the average of the annual mean concentration over three years. PM_{10} data were obtained from Silver Bay (7640-1), near the North Shore Mining site. The PM_{10} 24-hour background concentration is the high 2nd high value over the three-year period. Given there are no background concentrations for gaseous pollutants in the upper Minnesota area, design values from 2015 - 2017 for Rosemount (0423) south of Minneapolis/St. Paul were used for nitrogen dioxide, sulfur dioxide, and carbon monoxide. While this site is in an urban area, the monitoring location is away from major roadways that could influence the results. The 1-hour SO_2 background concentration is the three-year average of the 99th percentile of the annual distribution of daily maximum one-hour average concentrations, while the annual SO_2 and NO_2 concentrations are the average of the annual mean concentration over three years. The 24-hour and 3-hour SO_2 background concentrations are the second-high values over three years. The 1-hour NO_2 background concentration is the three-year average of the 98th percentile of the annual distribution of daily one-hour concentrations. The background CO concentrations are the high 2nd high value over the three-year period.

Abbreviations:
$\mu g/m^3$ = micrograms per cubic meter
Avg = average
Hr = hour
PM = particulate matter

11.1.2 Air Quality Standards

Through the federal Clean Air Act (CAA), under Title 42 U.S. Code Section 7401 et seq, the USEPA has developed National Ambient Air Quality Standards (NAAQS), under Title 40 Code of Federal Regulations Part 50, for criteria air pollutants relevant to the Project: NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, and lead. Under the applicable federal and state regulations, the primary standards are set to protect the public health, while secondary standards are designed to protect public welfare, including protection from damage to animals, crops, vegetation, visibility, and buildings. The USEPA has delegated authority for implementing these NAAQS standards to the MPCA. In Minnesota, the MPCA has promulgated ambient air standards known as the Minnesota Ambient Air Quality Standards under Minn. R., part 7009.0080. In addition to the criteria pollutants set forth by the USEPA, the Minnesota Ambient Air Quality Standards contain standards for total suspended particulate and hydrogen sulfide.

The Project may also be subject to regulation under Title 40 Code of Federal Regulations Part 52.21 which includes Class I and Class II Increment standards, Best Available Control Technology standards, and federal permitting thresholds; Federal Land Manager air quality related values including standards for visibility and deposition of acid and other pollutants in Class I areas; permitting, offsets, and stationary source requirements under Minn. R. parts 7007 and 7011; federal and state requirements for air toxics under CAA Section 112, Title 40 Code of Federal Regulations Part 63, Minnesota Air Emission Risk Analysis (AERA), and the Minnesota Statewide Mercury total maximum daily load (TMDL).

11.1.3 Ambient Air Quality Attainment Status

Under the CAA, the USEPA has defined all areas within the U.S. as one of two classifications: attainment or non-attainment. Attainment areas are those areas for which ambient air quality data has been collected that demonstrates that they are in compliance, or for which there are insufficient data to demonstrate non-compliance with NAAQS, known as unclassified areas. Various permitting programs, air quality standards, and emissions limits are in place to limit adverse air impacts within attainment areas. An area that does not meet NAAQS requirements for a particular pollutant is classified as a non-attainment area for that pollutant, and the USEPA requires the state to develop implementation plans to control existing and future emissions to bring the area into compliance with the NAAQS. The Project lies in an area that is designated as attainment or unclassified for air quality pollutants. Therefore, the non-attainment requirements are not applicable.

11.2 Project Impacts

11.2.1 Stationary Source Emissions

This section describes preliminary air emission sources anticipated for the underground mine, plant site, and tailings management site. Table 11-2 through Table 11-9 provide a list of anticipated emission sources and types, as well as preliminarily assumed quantities of emissions associate with those sources. Table 11-2 through Table 11-9 would be updated to reflect any additional sources included in the Project design and used in the additional modeling work discussed in Section 11.3.

Table 11-2 Underground Mine Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Ventilation Raise Site 1	Point / Fugitive	1.8	0.4	0.2	3.6	0.4	23.5
Ventilation Raise Site 3	Point / Fugitive	2.8	0.6	0.4	5.7	0.7	37.1
Conveyor Portal	Point / Fugitive	0.8	0.2	0.1	1.6	0.2	10.1

Table 11-3 Surface Material Transfer Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Main Conveyor to Primary Ore Storage Pile Feed Conveyor	Fugitive	0.14	0.046	0.014	0.00	0.00	0.00
Primary Ore Pile Feed Conveyor to Primary Ore Storage Pile	Fugitive	0.14	0.046	0.014	0.00	0.00	0.00
Primary Ore Storage Pile to semi-autogenous grind Mill Feed Conveyor	Fugitive	0.14	0.046	0.014	0.00	0.00	0.00
Semi-autogenous grind Mill and Conveyor/Hopper Transfer Area	Fugitive	0.13	0.009	0.003	0.00	0.00	0.00

Table 11-4 Surface Material Processing at Temporary Crusher Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Jaw Crusher and Transfer Points	Fugitive	0.08	0.02	0.007	0.00	0.00	0.00
Temporary Storage to Haul Truck	Fugitive	0.63	0.0001	0.00003	0.00	0.00	0.00

Table 11-5 Temporary Rock Storage Facility Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Material Handling	Fugitive	0.06	0.03	0.004	0.00	0.00	0.00
Vehicle Travel - Portal to temporary rock storage facility	Fugitive	0.17	0.04	0.004	0.00	0.00	0.00
Vehicle Travel - Temporary Crusher (temporary rock storage facility) to Primary Ore Storage	Fugitive	0.09	0.02	0.002	0.00	0.00	0.00

Table 11-6 Mill / Concentrator Building Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Copper Concentrate Handling	Fugitive	0.023	0.009	0.003	0.00	0.00	0.00
Nickel Concentrate Handling	Fugitive	0.011	0.004	0.001	0.00	0.00	0.00

Table 11-7 Product Truck Travel Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Roadway Emissions[1]	Fugitive	0.1	0	0	0.00	0.00	0.00

Notes:
[1] Roadway emissions include fugitive emissions from surface roadway travel, no tailpipe emissions. It includes emissions from concentrate trucks and cement / slag product delivery transferring materials from the process plant area to the main gate of the facility at the primary access road access point. Trucks moving ore on-site as part of the temporary rock storage facility are calculated separately. All on-site roadways are unpaved.

Table 11-8 Cement and Fly Ash Silos Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Cement/Slag Silo	Fugitive	0.005	0.002	0.001	0.00	0.00	0.00

Table 11-9 Tailings Management Site Preliminary Project Emission Sources

Source	Emission Source Type	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	NO_2 (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
Dry Stack Facility Wind Erosion[1]	Fugitive	1.2	0.6	0.09	0.00	0.00	0.00

Notes:
[1] For air dispersion modeling purposes, the entire area of the dry stack facility was assumed to be exposed.

11.2.1.1 Plant Site and Underground Mine Emissions

Sources of emissions from underground activities would include combustion emissions from use of propane for heating, drilling and blasting emissions, material handling, material transfer using conveyors, and use of up to three primary crushers at any one time to process ore. Final crushed ore would be transported to the surface using a main conveyor.

Underground emissions would be vented through two exhaust vents, one at ventilation raise site 1 and one at ventilation raise site 3. The mine would also exhaust passively from the mine access declines located at the plant site. However, it is anticipated only the decline that includes the main conveyor would vent particulate emissions from underground.

Conveyor transfer points include transfers from the decline to the secondary ore stockpile feed conveyor, as well as reclaim conveyor transfer points to service the secondary ore stockpile. Additional conveyor transfer points include a feed conveyor at the primary ore stockpile and a transfer point at the SAG mill. Conveyor transfer points would serve as potential emission sources.

There would be a potential for particulate emissions during off-loading of material from delivery trucks.

Travel along an on-site unpaved access road would be anticipated to be a potential source of emissions. The access road would be expected to accommodate approximately 40 concentrate transport trucks per day during normal operating conditions, and 80 concentrate transport trucks per day during springtime road conditions. There would be approximately 170, 20-ton trucks per month that would deliver fuel to the site. There would also be approximately 256, 20-ton trucks per month that would deliver binder material and processing reagents to the site. Product haul trucks and delivery trucks would enter and leave the mine site at the north end of the boundary through the access road.

During the construction phase (defined in Section 3.6.2), construction rock would be temporarily stockpiled within the footprint of the plant site for up to a week before it would be crushed and used as construction aggregate. There would be emissions from a temporary aboveground crusher near the portal when crushing the construction rock.

For up to the first two years of the operation phase (defined in Section 3.6.2), the material at the temporary rock storage facility would be crushed using a temporary aboveground crusher before being fed to the primary ore stockpile and processed through the concentrator. Emissions from a temporary aboveground crusher would be present while this material was being processed. Material at the temporary rock storage facility would nominally between 6 to 12 inches (10 to 30 cm) in diameter. Emissions from this source are expected to be minimal due to the large particle size.

Other than the material stockpiled at the temporary rock storage facility during construction, ore would be crushed underground and conveyed to surface while waste rock would remain underground as an initial fill for stopes prior to engineered tailings backfill.

11.2.1.2 Tailings Management Site

Sources of emissions from the tailings management site include up to 20 haul trucks used to transfer filtered tailings to the dry stack facility. Trucks would be anticipated to have a capacity of 40 - 60 tons of material. All haul trucks would be operated within the boundary of the Project area. At the dry stack facility, dewatered tailings would be offloaded at designated areas for placement and construction. The dry stack facility would be constructed in lifts over the lifetime of the Project.

Emissions for the dry stack facility are anticipated to manifest as fugitive dust emissions. These emissions would result from potential wind erosion occurring after placement of dewatered tailings within the dry stack facility. Water trucks would be utilized to control dust emissions on the haul roads and the dry stack facility as required.

11.2.1.3 Greenhouse Gas Emissions

In addition to gaseous criteria pollutants such as NO_2, SO_2, and CO, greenhouse gas (GHG) emissions are anticipated from mine heaters and underground blasting activities. Table 11-10 through Table 11-12 provides an estimate for preliminary GHG emissions anticipated for the Project. USEPA emission factors for liquid petroleum gas were used to estimate GHG emissions for combustion of liquid petroleum gas in mine heaters. For underground blasting activities, an emission factor for blasting activities associated with copper concentrate production in Australia was used as a representative benchmark. Preliminary GHG emission calculations show carbon dioxide equivalent emissions would be 58,072 tons per year (tpy), which is well below the threshold for a major source of air emissions of 100,000 tpy in Minnesota. This is based on the mine heaters being used at maximum capacity, 24-hrs per day, seven days per week, and six months out per year.

In the EIS, GHG information would be refined by inclusion of GHG emissions from certain on-site mobile sources of emissions, including haul trucks and loaders. The impact of GHG emissions would be further reviewed with respect to direct and indirect impacts from a regional and global perspective. Total GHG emissions from this Project would be compared against annual GHG emissions emitted globally, nationally, and within Minnesota. GHG emissions from the Project could then be assessed against overall contribution from each of these sectors as total emissions and as a percentage. Indirect impact evaluation would include evaluation of Project’s consumption of resources, including consumption of electrical power and fuel, and how this would impact GHG emissions. The EIS would also review potential methods to mitigate these impacts.

Table 11-10 Preliminary Estimations for Greenhouse Gas Emissions from Liquid Propane Gas Usage

Greenhouse Gases	Emission Factor (kg/MMBtu)[1]	Emission Factor (lb/MMBtu)	Emissions (ton/yr)	Global Warming Potential[2]	Emissions (CO_2e Short Tons)
Carbon Dioxide	61.71	136.07055	45295	1	45295
Methane	0.003	0.006615	2	25	55
Nitrous Oxide	0.006	0.001323	0.4	298	131

Notes:
LPG usage assumed the maximum heat input rating for burners (76 MMBtu/hour), for two burners, operating 24 hours a day, 7 days a week, 6 months out of the year (4380 hours). Actual hours of operation are expected to be less.
[1] Emission factors obtained from Tables C-1 and C-2 to 40 CFR part 98, subpart C.
[2] Global warming potential obtained from Table A-1 to 40 CFR part 98, subpart A.
Abbreviations:
CO_2e = CO_2 equivalents
kg/MMBtu = kilograms per million British thermal units squared
lb/MMBtu = pounds per million British thermal units
ton/yr = tons per year

Table 11-11 Preliminary Estimations for Greenhouse Gas Emissions from Water-Based Blasting Emulsion

Anticipated Ore Blasted Annually (tons/yr)	Anticipated Ore Blasted Annually (tonnes/yr)	Blasting Emission Factor (kg CO_2e/tonne ore)[1]	Total Emissions (kg CO_2e/year)
8,030,000	**8,158,480**	**1.4**	**11,421,872**

Notes:
[1] The emission factor was obtained from the following paper: Norgate, T. and Haque, N., 2010. Energy and Greenhouse Gas Impacts of Mining and Mineral Processing Operations, Journal of Cleaner Production, 18: pp. 266-274. Table 3 in the article provides GHG emission factors for blasting associated with copper production. However, the emission factor appears to be for use of ANFO rather than a water-based emulsion, so it is probably conservative. The USEPA and other sources do not provide emission factors for GHG associated with blasting emissions.
Abbreviations:
CO_2e/year = CO_2 equivalents per year
GHG = greenhouse gas
kg CO_2e/year = kilograms of carbon dioxide equivalents per year
ton/yr = tons per year
tonnes/yr = tonnes per year

Table 11-12 Preliminary Estimations for Greenhouse Gas Emissions

Global Warming Potential[1]	Emissions (CO_2e Short Tons)
Total GHG Emissions (CO_2e Short Tons)[2]	45,481
Total Emissions (Short Ton CO_2e/year)	12,590
Total GHG Emissions	58,071

Notes:
[1] Global warming potential obtained from Table A-1 to 40 CFR part 98, subpart A.
[2] There is no information regarding expected GHG emissions from use of water emulsion explosives. Emission factors for this potential source are not available; therefore, potential GHG emissions were not estimated from this source.
Abbreviations:
CO_2e = CO_2 equivalents
CO_2e/year = CO_2 equivalents per year
GHG = greenhouse gas

11.2.2 Class II Air Dispersion Modeling and Prevention of Significant Deterioration Review

Preliminary air modeling was conducted to compare potential emissions of PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO to NAAQS and the applicable prevention of significant deterioration (PSD) increment standards. This initial modeling characterized the sources identified in Section 11.2.1 as either point sources (stack sources) or fugitive emission sources. All emission estimates are based on a maximum ore processing rate of 22,000 tons per day (tpd) and waste rock production of 3,300 tpd.

11.2.2.1 NAAQS

Preliminary results indicate that concentrations of PM_{10} would be below the applicable 24-hour NAAQS for PM_{10} of 150 micrograms per cubic meter (µg/m^3). This is after including the applicable background concentration of 70 µg/m^3.

Similarly, $PM_{2.5}$ is anticipated to be below the applicable 24-hour NAAQS of 35 µg/m^3. This is after including the applicable background concentration of 17 µg/m^3.

Preliminary modeling also evaluated NO_2, SO_2, and CO for the underground blasting activities and propane mine heaters. Based on preliminary designs, a source of air emission factors for water-based emulsion was utilized to estimate emissions of NO_2, SO_2, and CO from blasting activities. Modeled results indicate that ambient concentrations would be below the annual NO_2 NAAQS of 100 µg/m^3, as well as the 1-hour NO_2 standard of 188 µg/m^3.

Results for SO_2 indicate the Project would meet the annual, 24-hour, 3-hour, and 1-hour NAAQS of 80 µg/m^3, 365 µg/m^3, 1,300 µg/m^3, and 196 µg/m^3, respectively. Modeled concentrations would also be less than the 8-hour and 1-hour CO NAAQS of 10,000 and 40,000 µg/m^3, respectively.

A summary of preliminary air modeling results compared to NAAQS can be found in Table 11-13. To continue to understand the extent of potential air impacts, this table would be updated as the modeling work outlined in Section 11.3 is completed.

Table 11-13 Modeled Emissions Compared to National Ambient Air Quality Standards

Criteria Pollutant	Averaging Period	Meteorological Data Year	Preliminarily Modeled Ambient Impact ($\mu g/m^3$)	Background Concentration[1] ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	National Ambient Air Quality Standards ($\mu g/m^3$)
$PM_{2.5}$ (2)	Annual	2012-2016	0.42	4.0	4.42	12
$PM_{2.5}$ (3)	24-Hr Avg	2012-2016	4.37	12	16.37	35
PM_{10} (4)	24-Hr Avg	2012-2016	13.7	70	83.7	150
SO_2	Annual	2012-2016	0.7	1.6	2.3	80
SO_2 (5)	24-Hr Avg	2012-2016	17.3	3.7	21	365
SO_2 (5)	3-Hr Avg	2012-2016	78.1	7.8	85.9	1,300
SO_2 (6)	1-Hr Avg	2012-2016	93.8	10.5	104.3	196
NO_2	Annual	2012-2016	2.8	5.6	8.4	100
NO_2 (7)	1-Hr Avg	2012-2016	132	45	177	188
CO (5)	8-Hr Avg	2012-2016	2,224	600	2,824	10,000
CO (5)	1-Hr Avg	2012-2016	8,174	800	8,974	40,000

Notes:

[1] Background ambient air concentrations are calculated design values based on data provided by the MPCA through its Criteria Pollutant Data Explorer website. $PM_{2.5}$ data were obtained from Ely, Minnesota (0005). Using MPCA guidance for calculation of background concentrations, the $PM_{2.5}$ 24-hour background concentration is the average of the 98th percentile 24-hour values over three years. The $PM_{2.5}$ annual background concentration is the average of the annual mean concentration over three years. PM_{10} data were obtained from Silver Bay (7640-1), near the North Shore Mining site. The PM_{10} 24-hour background concentration is the high 2nd high value over the three-year period. There are no background concentrations for gaseous pollutants in the upper Minnesota so design values from 2015 - 2017 for Rosemount (0423) south of Minneapolis/ St. Paul were used for nitrogen dioxide, sulfur dioxide, and carbon monoxide. While this site is in an urban area, the monitoring location is away from major roadways that could influence the results. The 1-hour SO_2 background concentration is the three-year average of the 99th percentile of the annual distribution of daily maximum one-hour average concentrations, while the annual SO_2 and NO_2 concentrations are the average of the annual mean concentration over three years. The 24-hour and 3-hour SO_2 background concentrations are the second-high values over three years. The 1-hour NO_2 background concentration is the three-year average of the 98th percentile of the annual distribution of daily one-hour concentrations. The background CO concentrations are the high 2nd high value over the three-year period.

[2] The $PM_{2.5}$ annual value is the highest annual average concentration over five years of meteorological data.

[3] The $PM_{2.5}$ 24-hour concentration is the highest eighth high concentration over five years of meteorological data.

[4] The PM_{10} 24-hour concentration is the highest sixth high concentration over five year of meteorological data.

[5] The SO_2 24-hour and 3-hour values and CO 1-hour and 8-hour values are highest 2nd high concentrations over 5 years of meteorological data. These values are used for assessing compliance with the National Ambient Air Quality Standards.

[6] The SO_2 1-hour value is the 5-year average of the fourth-highest daily maximum 1-hour concentrations. This is representative of the 99th percentile of the daily maximum 1-hour concentration.

[7] The NO_2 1-hour value is the 5-year average of the eighth-highest daily maximum 1-hour concentrations. This is representative of the 98th percentile of the daily maximum 1-hour concentrations.

Abbreviations:
µg/m3 = microgram per cubic meter
Avg = average
Hr = hour
PM = particulate matter

11.2.2.2 PSD

A permit applicability analysis was conducted as part of the dispersion analysis for the underground mine, plant site, and tailings management site. This analysis reflected the federal PSD requirements of the Clean Air Act, which provide for a pre-construction review and permit process of new or modified major stationary sources of emissions in attainment areas. The PSD program is intended to prevent degradation of air quality within attainment areas. The PSD air permitting program is triggered at 100 tpy for a Project if it falls within one of 28 industrial categories, or 250 tpy for all other facilities. There are two primary regulatory classifications under the PSD program, Class I areas (which include national parks, national monuments, and wilderness) where air quality should be given special protection, and Class II areas, which includes most other locations.

For attainment areas, the USEPA has promulgated PSD increments (allowable increases in emissions above certain baselines) for four pollutants (NO_2, SO_2, PM_{10}, and $PM_{2.5}$) for both Class I and Class II areas. The Project would be located within a Class II attainment area, as designated by the USEPA and the MPCA.

Through the use of controls such as sprays, wet material, locating emission sources indoors, or the use of dust collection equipment, preliminary modeling indicates the potential emissions of federal hazardous air pollutants (HAP) would fall below major source triggers of 10 tpy for an individual HAP and 25 tpy for aggregate HAPs. While comparison against PSD Class II increments is always required for major PSD sources of air emissions, it can also be triggered for other air emission sources in air quality regions where the "minor source baseline" has been set. This baseline is set when the first PSD major source air permit is issued for that region. According to MPCA records, minor source baselines for PM_{10}, NO_2, and SO_2 have been set in both Lake and St. Louis Counties. The MPCA has indicated in its MPCA Air Dispersion Modeling Practices Manual (MPCA, 2016) that consideration of PSD increments may be required for certain emission sources not undergoing PSD review. There are six criteria listed in the guidelines that are used to determine the need for consideration of PSD increment consumption. These six criteria are as follows:

- Triggering PSD, non-attainment area New Source Review, or environmental review;
- The installation of non-emergency internal combustion engines;
- The Project would be located in a non-attainment or maintenance area for a related pollutant;
- Existing modeling that indicates a potential threat to the NAAQS;
- An increase in emissions of a related pollutant; and
- Public interest.

Given these criteria, air dispersion modeling results have been compared against applicable PSD increments. All preliminary air emission estimates comply with the applicable PSD increment.

A summary of preliminary air modeling results compared to PSD requirements can be found in Table 11-14. Note that the $PM_{2.5}$ Class II minor source baseline has not been set for Lake County, therefore, the $PM_{2.5}$ Class II PSD increment is not applicable to the Project. However, there is a possibility that this baseline could be triggered by a major source of air emissions near the time the facility is ready to seek an air permit. Table 11-14 would be updated as preliminary Class II air dispersion modeling work is updated and refined to reflect Project operations and modeling work outlined in Section 11.3 is completed.

Table 11-14 Modeled Emissions Compared to Prevention of Significant Deterioration

Criteria Pollutant	Averaging Period	Meteorological Data Year	Preliminarily Modeled Impact (µg/m^3)	Prevention of Significant Deterioration Increment - Class II (µg/m^3)
$PM_{2.5}$ (1,2)	Annual	2012-2016	0.42	4
$PM_{2.5}$ (1,3)	24-Hr Avg	2012-2016	7.6	9
PM_{10} (2)	Annual	2012-2016	0.8	17
PM_{10} (3)	24-Hr Avg	2012-2016	16.6	30
SO_2	Annual	2012-2016	0.7	20
SO_2 (3)	24-Hr Avg	2012-2016	17.3	91
SO_2 (3)	3-Hr Avg	2012-2016	78.1	325
NO_2 (2)	Annual	2012-2016	2.8	25

Notes:
[1] The minor source baseline date for $PM_{2.5}$ has not been triggered for Lake County in Minnesota. Therefore, non-major sources such as TMM do not need to comply with the $PM_{2.5}$ Prevention of Significant Deterioration increment.
[2] Annual results are the highest annual average concentration for the referenced modeling period.
[3] All short-term values (non-annual) are the highest 2nd high concentrations over five years of meteorological data: 2012 through 2016.

Abbreviations:
µg/m^3 = microgram per cubic meter
Avg = average
Hr = hour
PM = particulate matter

11.2.3 Class I Areas

The BWCAW is located approximately five miles northeast of the Project. Preliminary Class II air dispersion modeling results show particulate matter impacts to be very low at this distance from the Project. For example, PM_{10} concentrations were at 0.003 µg/m3 at the BWCAW boundary compared to the 24-hour NAAQS of 150 µg/m3. While preliminary emission calculations indicate the Project would not be a major source of air emissions and trigger an analysis of impacts to Class I areas under the CAA, there may be interest in further assessing these impacts within the EIS. The specific requirements for a Class I area impact analysis would be discussed with the RGU as part of the air quality impact analysis process. This process would be conducted to satisfy environmental review requirements. One task could include Class I air dispersion modeling using a refined air dispersion model that assesses impact to receptors beyond 50 kilometers of the Project and within 300 kilometers of identified Class I areas near the Project. Other tasks may include assessments of

Class I increment effects, acid deposition on ecosystems, and a visibility impacts analysis.

11.2.4 Vehicle Emissions

Most vehicle emissions are anticipated to come from four sources:

- Underground internal combustion engines;
- Over-the-road concentrate cartage trucks;
- On-site haul trucks used to transfer tailings filter cake; and
- Non-company supply delivery vehicles.

As discussed in Section 11.2.1, haul trucks would be used on-site to transfer tailings filter cake from the tailings dewatering plant to the dry stack facility. The Project design utilizes 15 to 20 trucks that would have the capacity to transfer 40 tons of material at a time. Minor vehicle emissions are expected from other aboveground mobile equipment which may include, but are not limited to, maintenance trucks, graders, forklifts, and loaders. Vehicle tailpipe emissions include criteria pollutants such as NO_2, SO_2, and CO, and PM as well as GHG emissions and air toxics. Vehicle tailpipe emissions will be included in the emissions calculations future scope described in Section 11.3.1.

Potential impacts to air quality may include, but are not limited to, the following:

- Health risks from air toxics assessed in accordance with the AERA process;
- Visibility, acid deposition, and deposition of sulfur, nitrogen, and mercury in Class I Areas; and
- Direct and indirect GHG impacts.

11.2.5 Dust and Odors

Fugitive dust and odor sources are primarily generated from windblown dust, fueling station vapors, earth moving activities, and flotation circuits. Modeled emissions of PM_{10} and $PM_{2.5}$ would comply with the applicable NAAQS for each form of particulate matter.

Potential impacts to air quality may include, but are not limited to, the following:

- Fugitive dust generation due to construction and operation-related activities;
- Changes to air quality and visibility in surrounding areas resulting from fugitive dust-creating activities, combustion equipment, and ventilation fan emissions; and
- No impacts resulting from odors are anticipated.

11.2.6 Human Health and Sensitive Receptors

Residential properties are located to the north of the plant site, tailings management site, and underground mine. Prevailing winds are most commonly from the northwest; these residential properties will be upwind of the Project when the wind is from the northwest. There are also recreational users of Birch Lake to the west and recreational users of the SNF surrounding the area. Generally, these residential properties are occupied during warmer months and recreational users are present intermittently in these areas. These areas are considered to be sensitive receptors in that there would be a potential that air emissions could impact human health due to proximity to the Project. However, Preliminary air dispersion modeling has demonstrated that concentrations of priority air pollutants such as PM, SO_2, NO_2, and CO would meet federal and state ambient air quality standards in these areas. Preliminary air dispersion modeling also indicates that fence-line concentrations of selected metal HAPs, including mercury, pose low inhalation risk as metal air toxics based on the AERA process.

The ore that would be processed contains non-asbestiform mineral fibers. Non-asbestiform concentrations in ore for the Project would be reviewed and characterized further from an air quality standpoint. The potential impacts on human health would then be discussed further in the EIS with input from the RGU.

In order to limit potential emissions and impacts to human health, air quality management for the Project would include control of point source emissions and fugitive dust emissions. Control of point source emissions from activities in the underground mine, the plant site, and the tailings management site, would include:

- Proper use of engineered control equipment (wet scrubbers, dust collectors, etc.);
- Ensuring complete combustion of blasting materials through proper blast design protocols;
- Implementing water sprays at transfer points;
- Proper maintenance of site infrastructure to ensure equipment is properly functioning; and
- Hooded / covered transfer points; or backfilling of materials so they are not point source emissions.

Control of fugitive dust emissions from the plant site and tailings management site may include as appropriate:

- The use of speed limits on unpaved roads;
- Watering unpaved roads;
- Revegetation of disturbed surfaces;
- Proactive road maintenance; or
- Use of dust suppression chemicals.

11.2.7 Air Impacts Summary

Available information to fully assess potential Project air impacts is insufficient but could be reasonably obtained. Potential impacts have been preliminarily identified, and future work is planned to assess their nature and extent. These impacts are preliminarily characterized in the following manner:

- Emissions would be temporary, occurring only during construction and operation phases of the Project. Revegetation practices associated with reclamation would reduce fugitive dust emissions during the reclamation and closure phase. Fugitive dust emissions would be mitigated in the post-closure phase.

- Based on preliminary modeling, the extent of emissions for both NAAQS and PSD would be within allowable ranges. Engineering controls and fugitive dust management practices would be employed throughout the construction, operation, and reclamation and closure phases of the Project.
- Based on the emission calculations, EPMs identified for the Project, and preliminary air modeling results, potential impacts to the environment and human health are anticipated to be minor.

Further work to assess potential air impacts is outlined in Section 11.3.

11.3 Future Scope

Based on preliminary information and initial modeling, the following will be addressed further in the EIS:

11.3.1 Emission Calculations

Preliminary emission calculations for the Project will be further refined to include all operations, including activities and equipment not included to date. In addition, all air toxics associated with the Project (including metal-bearing process materials and combustion activities) will be included in the evaluation. Human risk to air toxics will be fully evaluated using the Minnesota AERA process.

Preliminary emission calculations for the Project will be further refined to include all operations, including equipment and activities and emissions associated with sources generating fugitive dust not included to date.

11.3.2 Greenhouse Gas Emissions

In the EIS, GHG information will be refined by inclusion of GHG emissions from certain on-site mobile sources of emissions, including haul trucks and loaders. The impact of GHG emissions will be further reviewed with respect to direct and indirect impacts from a regional and global perspective. Total GHG emissions from this Project will be compared against annual GHG emissions emitted globally, nationally, and within Minnesota. GHG emissions from the Project could then be assessed against overall contribution from each of these sectors as total emissions and as a percentage. Indirect impact evaluation will include evaluation of Project's consumption of resources, including consumption of electrical power and fuel, and how this will impact GHG emissions. Total accumulation of greenhouse gases from the Project and all global sources will be evaluated to support the cumulative potential effects analysis in Section 14.0. The EIS will also review potential methods to mitigate these impacts

11.3.3 Class II Air Dispersion Modeling

Preliminary Class II air dispersion modeling will be updated and further refined as emission calculations are updated and additional information about operations are obtained. This will include refinement of the site boundary and expansion and modification of the receptor grid outside the boundary to include sensitive receptors.

11.3.4 Class I Air Quality Analysis

The specific requirements for a Class I area impact analysis will be negotiated and discussed with the RGU as part of the air quality impact analysis process. This process will be conducted to satisfy environmental review requirements. One task could include Class I air dispersion modeling assessing PSD Significant Impact Levels impacts using a refined air dispersion model that assesses impact to Class I areas within 300 kilometers of the Project. Other tasks could include assessments of Class I increment effects, acid deposition on ecosystems, and visibility impacts analysis of haze, coherent plumes, or both.

11.3.5 Cross-Media Impacts and Cumulative Impacts

The EIS will review information on cross-media impacts, including deposition of metals and sulfate on nearby streams, lakes and wetlands. The scope will include deposition modeling of metal and sulfate emissions from the Project to quantify annual load at selected nearby receptors. Output from the model will be coupled with water flows to estimate concentrations due to deposition from Project activities. Concentrations could then be compared to protective water quality standards and/or recommended levels. This model will inform potential impacts to and define the future work scope for aquatic resources.

11.3.6 Visual Impacts Analysis

The specific requirements for a visual impact analysis will be negotiated and discussed with the RGU as part of the visual impact analysis process. This process will be conducted to satisfy environmental review requirements. Associated tasks could include assessing the potential for physical changes to the visual environment at surrounding receptors, assessment of visible plumes or fogging at selected receptors, and simulation of changes to particular scenic vistas.

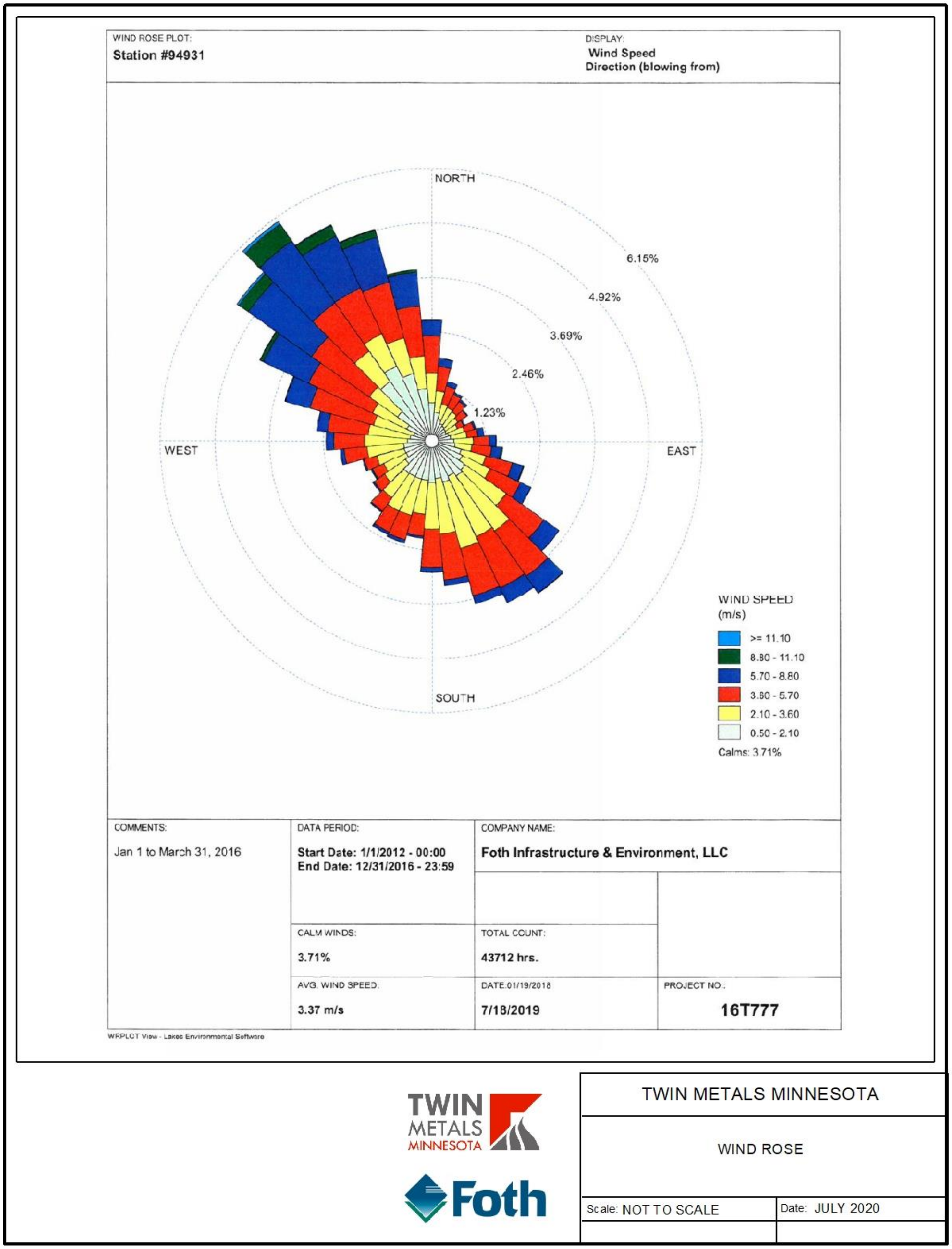


Figure 11-1 Wind Rose

12.0 NOISE

12.1 Baseline Conditions

The Project would be located within the SNF, an area characterized by manmade noise associated with recreation activities such as OHV use, boating, and vehicle travel, resource management activities such as exploratory drilling and timber harvest, and natural noises such as wind and wildlife activity.

12.1.1 Baseline Ambient Noise

Baseline ambient noise level data was collected by the USFS within the SNF in the vicinity of the Project area between 2014 and 2016. Data provided to TMM by the USFS in September 2017 included a total of 11 measurement sites, five of which were identified as being located proximal to the Project area. Figure 12-1 shows the location of the 11 sites. For the five sites identified as proximal to the Project area, data were collected during winter months (January – March), when human noise producing activity and natural noise producing sources are at a minimum; therefore, the data collected by the USFS during this survey represents the lowest anticipated ambient noise levels that can be expected. Timing of data collection varied at the other six sites and included summer and fall measurements, which provided context for seasonal variation.

Data from three of the 11 collection sites supplied by the USFS were used by TMM to assess baseline ambient noise levels within the vicinity of the Project; these sites included River Point Resort, Spruce Road, and Birch West. River Point Resort was chosen because it would be the closest location to the plant site and this site would be near some of the most important noise-sensitive receptors. Spruce Road was chosen because the data were collected during the fall rather than the winter and may identify seasonal noise variations. Birch West was chosen because measurements there were made in the spring and summer and may also be used to identify seasonal noise variations.

An analysis of the data included an assessment of the 1-hour average calculated from the one-second measure for each location in accordance with Minnesota noise regulation specifically Minn. R., part 7030.0040 which limits noise on a 1-hour average basis. Additionally, the data for each location were used to identify the minimum and maximum values during both daytime and nighttime periods. The results of this analysis are shown in Table 12-1 and indicate times that are very quiet (<20 dBA) for each location and times that are loud with maximum 1-hour levels reaching 50 to 60 dBA for each area. The average levels for River Point and Spruce Road locations were similar (30 dBA); however, the average at Birch West was 10 dBA louder (40 dBA), potentially indicating seasonal changes in ambient noise levels.

Table 12-1 Baseline Ambient Noise Levels

Measurement Location	Daytime Minimum (1-hour L_{eq} dBA)	Daytime Average (1-hour L_{eq} dBA)	Daytime Maximum (1-hour L_{eq} dBA)	Nighttime Minimum (1-hour L_{eq} dBA)	Nighttime Average (1-hour L_{eq} dBA)	Nighttime Maximum (1-hour L_{eq} dBA)
River Point Resort	<20	30	~50	<20	27	~50
Spruce Road	<20	30	~50	<20	27	~55
Birch West	~20	40	~60	<20	36	~60

Abbreviations:
~ = approximately
< = Less than
dBA = adjusted decibels
Leq = equivalent continuous sound level

12.1.2 Nearby Sensitive Receptors

A total of 55 nearby sensitive receptors were identified including residences (single-family homes or cabins) to the north and to the west (across Birch Lake), camping to the north (South Kawishiwi River Campground), west (two backcountry sites on the east shore of Birch Lake), and southwest (Birch Lake Campground), and a resort (River Point Resort & Outfitting Co.) across South Kawishiwi River to the northwest) as shown on Figure 12-2.

12.1.3 State Noise Standards

Minnesota establishes noise level limits according to the land use activity at the location of the receiver. Land uses are divided into the following four noise area classifications (NAC):

- NAC 1: Residential housing, religious activities, camping and picnicking areas, health services, hotels, educational services;
- NAC 2: Retail, business and government services, recreational activities, transit passenger terminals;
- NAC 3: Manufacturing, fairgrounds and amusement parks, agricultural and forestry activities; and
- NAC 4: Undeveloped and unused land.

The limits for each NAC are identified in Minn. R., part 7030.0040 and are outlined in Table 12-2. The statistical limits identified in Table 12-2 are defined in terms of the level exceeded 50% of the time period of interest (one hour in this case), which is denoted L_{50}, and expressed in units of A-weighted dBAs. A separate statistical limit, L_{10}, refers to the level exceeded 10% of the time period. Nearby sensitive receptors to the Project identified in Section 12.1.2 would primarily be associated with the NAC-1 classification. This classification would require a nighttime L_{50} of 50 dBA or less from the Project.

Table 12-2 State of Minnesota Hourly Noise Limits per Minnesota Rule part 7030.0040 (dBA)

Noise Area Classification	Daytime (7am to 10pm) L_{10}	Daytime (7am to 10pm) L_{50}	Nighttime (10pm to 7am) L_{10}	Nighttime (10pm to 7am) L_{50}
1	65	60	55	50
2	70	65	70	65
3	80	75	80	75

Note:
There are no noise standards for NAC-4.
Abbreviations:
dBA = adjusted decibels
L_{10} = 10 percent of the unit of time measured
L_{50} = 50 percent of the unit of time measured

12.2 Project Impacts

12.2.1 Source, Characteristics, Duration, Quantities, and Intensity

An analysis of potential noise emissions associated with the construction and operation of the Project was conducted to assess potential impacts. This analysis was developed using International Organization for Standardization (ISO) 9613-2:1996 (ISO, 1996) methods and implemented using SoundPLAN software. The following parameters were assumed for the noise analysis:

- Completely reflective ground for the plant site (often hard packed soil or pavement);
- Completely reflective water bodies (Birch Lake);
- 50% absorption from other areas which are mainly forested;
- Receptors were modeled at a height of 5 ft aboveground (industry standard); and
- Air temperature, relative humidity, and atmospheric pressure were set to 50°F (10°C), 70%, and one atmosphere, respectively, which are commonly used to represent minimal absorption.

Noise emissions from the Project would be subject to Minnesota regulations, which defines daytime and nighttime noise limits for different types of properties. Because the Project would operate 24-hrs per day, the more restrictive nighttime limits within the NAC-1 classification would apply. Residential and camping / picnicking areas have a nighttime L_{50} limit of 50 dBA (1-hour L_{50}) and 55 dBA (1-hour L_{10}). For relatively steady-state noise sources, which mining operations are considered to be given the distance between sources and receptors, compliance with the L_{50} standard is expected to result in compliance with the L_{10} standard.

Sources of noise during the operation phase of the Project may include the following equipment:

- Processing facilities
- Ventilation fans
- Propane heaters
- Ore conveyors
- Maintenance activities
- Substations
- Water intake pumps
- Filtration plant operations
- Air compressors
- Backfill plant operations
- Haul truck
- Water truck
- Bulldozer
- Excavator
- Front-end loader
- Vibratory rollers

Noise levels associated with these potential sources were identified from previous measurements at other existing operations, manufacturer specifications associated with individual pieces of equipment, or literature review.

In order to conservatively assess potential noise impacts, the analysis assumed all mobile equipment associated with the tailings management site was operating along the crest of the dry stack facility closest to the sensitive receptors, with no EPMs in place. The result of this conservative analysis identified that noise levels at sensitive receptors ranged from 0 to 42 dBA, which are well below the NAC-1 nighttime standard of 50 dBA.

12.2.2 Quality of Life

The ambient noise monitoring data collected by the USFS indicate baseline ambient noise of the three locations ranges from <20 dBA to approximately 50 dBA. Of these three sites, two were found to have averages of 30 dBA and one was found to have an average of 40 dBA. The extent of anticipated noise impacts associated with the operation phase of the Project is 42 dBA. This level falls below the L_{50} nighttime requirement identified by Minnesota Administrative Rules for NAC-1 designated areas and is similar to current ambient noise levels.

12.2.3 Noise Impacts Summary

In order to ensure noise levels remain below the NAC-1 nighttime limit of 50 dBA, the Project would include the following noise reduction technologies:

- Construction materials with a higher sound transmission class rating;
- Acoustically treated ventilation openings;
- Silencers for ventilation raise exhausts; and
- Transfer point barriers for conveyors.

The available information is adequate to make a reasoned decision about the potential for, and significance of, Project noise impacts. Potential noise impacts during operations, as well as the potential impacts to quality of life are characterized in the following manner:

- Timing – Potential noise impacts would occur only during the life of the Project;
- Extent – The reach of potential noise impacts would be limited to sensitive receptors proximal to the plant site, tailings management site, and ventilation raise sites. The extent of this impact in not anticipated to exceed the nighttime L_{50} standard set by Minn. R., part 7030.0040. No noise impact was identified that would fall outside of the baseline ambient noise range was identified for the Project; and
- Regulatory Oversight – Potential noise impacts associated with the Project would be subject to ongoing oversight by the MPCA, through the anticipated implementation of an air permit.

The assessment of potential impacts from noise associated with the Project indicates the topic would be minor.

12.3 Future Scope

The future scope for noise will build off the baseline conditions and impact analysis presented in this data submittal. The purpose of this work will be to provide information to further characterize the baseline conditions of the Project and proposed alternatives and discuss detailed impact analysis conducted during, the EIS process. Baseline data collection will include characterizing the regional setting and Project location including:

- the Ely Municipal Airport;
- traffic on nearby roads and highways, nearby snowmobile and ATV trails;
- motorboat traffic; and
- traffic related to the Kasota Stone quarry.

The noise analysis will also verify and update sensitive receptors and collect additional ambient noise level data, where necessary.

An updated impact analysis will be conducted by describing the area of analysis for direct and indirect impacts due to noise conditions. Impact assessment will include determining the maximum sound power levels of major Project equipment and modeling the transmission of sound through the environment. This modeling will allow for evaluation of potential noise effects on noise sensitive receptors within the analysis area. Impacts will be assessed using indicators that may include:

- Exceedance of noise emissions standards:
    - Daytime noise limits
    - Nighttime noise limits
    - Compliance with the L_{50} standard
- Change from the ambient noise due to Project activities

Using the methods and indicators, the impacts resulting from the Project or any alterative will be compared against the baseline conditions to characterize the effects to existing noise conditions. The results of the baseline characterization, impact analysis, and effect to noise resources will be part of the Noise and Vibration Data Package provided during EIS development.

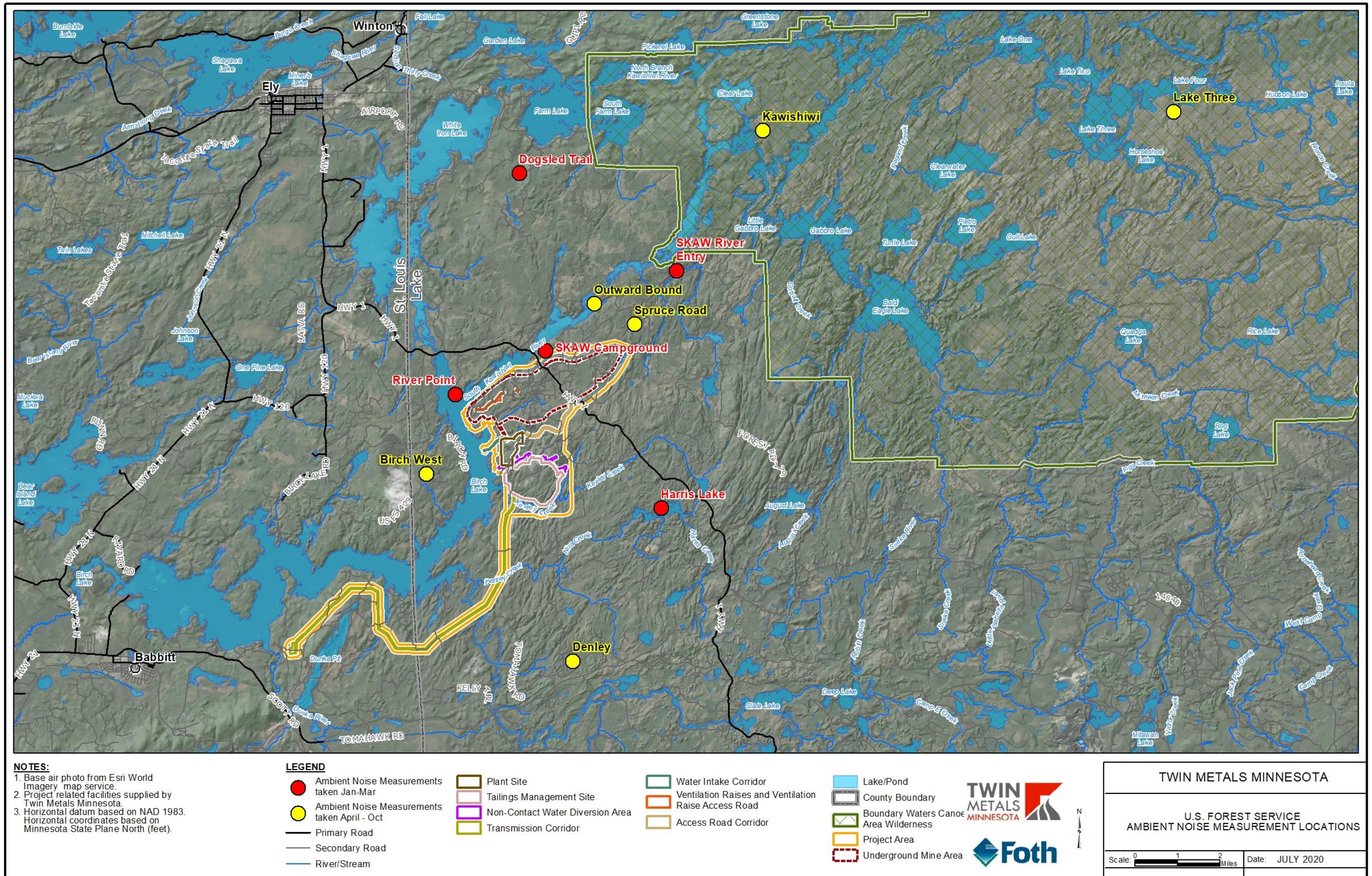
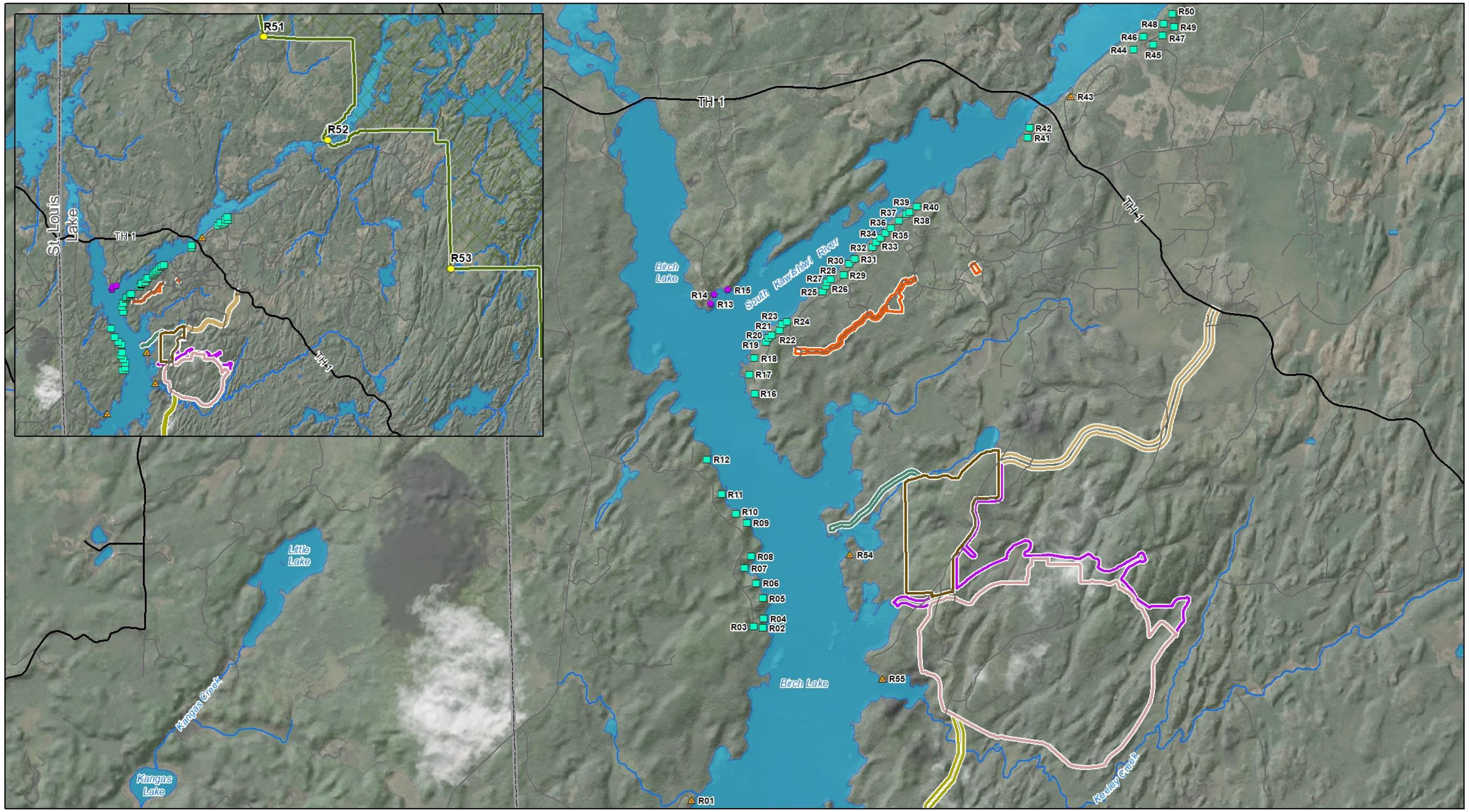


Figure 12-1 U.S. Forest Service Ambient Noise Measurement Locations



NOTES:
1. Base air photo from Esri World Imagery map service.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. Noise Receptors were supplied by HEI.

LEGEND

- Recreation
- Residence
- Resort
- Primary Road
- Secondary Road
- River/Stream
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor
- Lake/Pond
- County Boundary

TWIN METALS MINNESOTA

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N

TWIN METALS MINNESOTA

SENSITIVE RECEPTORS - NOISE

Scale: 0 0.25 0.5 Miles

Date: JULY 2020

Figure 12-2 Sensitive Receptors - Noise

13.0 TRANSPORTATION

13.1 Baseline Conditions

Annual average daily traffic (AADT) is a measure commonly used to identify baseline traffic conditions for projects that may have transportation implications. *MnDOT's Traffic Mapping Application* (MnDOT, 2018), an interactive web tool that allows users to review spatial traffic data, was used to determine baseline AADT on the following roadways associated with the Project: TH 1, St. Louis County Road (CR) 21 / CR 120, New Tomahawk Road, National Forest Road (NFR) 1900, and NFR 1901 shown on Figure 13-1. NFR 1436 and 1493 are secondary access roads and were therefore not considered in the baseline.

13.1.1 Traffic Conditions

The following are baseline traffic conditions for roadways which would be impacted by the Project.

13.1.1.1 Regional Corridors

The section of TH 1 between the Project area and Ely, Minnesota is a paved two-lane roadway with an AADT volume of 1,150 daily trips. TH 1 to the southeast of the Project is also a paved two-lane roadway with an AADT volume between 375 to 930 daily trips.

The portion of CR 21 / CR 120 between Babbitt, Minnesota and TH 1 is a paved two-lane roadway with AADT volume ranging from 360 daily trips on CR 120 to 1,400 daily trips on CR 21. The portion of CR 21 to the west of Babbitt has an AADT volume of 2,000 daily trips.

New Tomahawk Road is a rural, unpaved two-lane roadway with an AADT of 130.

13.1.1.2 Local Roads / National Forest Roads

NFR 1900 is located north / northeast of the plant site and intersects TH 1. NFR 1900 is currently an unpaved rural roadway. No AADT information is available for NFR 1900.

NFR 1901 is currently an unpaved rural roadway located north of the plant site. No AADT information is available for this NFR 1901.

13.1.1.3 Local Roads / State Forest Roads

Minimum Maintenance Road (MMR) 1492 is currently an unpaved minimum maintenance road located on the western side of the dry stack facility. No AADT information is available for MMR 1492.

MMR 1494 is currently an unpaved minimum maintenance road that provides access to state lands along North Nokomis Creek (Kittle Number: H-001-092-017.4) located east of the ventilation raise site 3 where it intersects NFR 1900. No AADT information is available for MMR 1494.

13.1.2 Traffic Forecast

Using historic traffic volumes identified from MnDOT's mapping application, traffic forecasts were developed for key regional corridors, local roads, and NFRs, where data was available. A straight-line growth factor was applied to the historic traffic volumes in order to forecast AADT values in the year 2040. As a result of stable traffic patterns over the previous 10 to 20 years on key regional corridors, the straight-line growth factor that was applied was flat, indicating no growth should be applied to the existing AADT values. The forecast traffic volumes identified by this approach can be found in Table 13-1.

Table 13-1 Existing and Forecast Annual Average Daily Traffic with and without Project Trips

Route	Description	Existing Annual Average Daily Traffic	Forecast (2040) Annual Average Daily Traffic	Project Generated Trips	Existing and Forecast (2040) Annual Average Daily Traffic with Project Generated Trips
TH 1	Between plant site and Ely, Minnesota	1,150	1,150	170	1,320
New Tomahawk Road	Between Babbitt and TH 1	130	130	0	130
CR 21	East of Salo Road and Babbitt, Minnesota	2,000	2,000	704	2,704

13.1.3 Regional Transportation System

In addition to baseline traffic volumes and forecast traffic volumes, the current condition of regional transportation systems was assessed using the Federal Highway Administration's *Simplified Highway Capacity Calculation Method for the Highway Performance Monitoring System Report* (Margiotta and Washburn, 2017). This approach uses daily traffic volumes to determine a level of service (LOS) that can be applied to individual roadways. Six LOS levels are defined, designated by letters A through F. LOS A represents the best operating conditions (no congestion), and LOS F represents the worst operating conditions (severe congestion).

Application of this method to regional roadways TH 1, New Tomahawk Road, and CR 21 / CR 120 indicates the current designation for these roadways is LOS A.

13.2 Project Impacts

A transportation assessment was completed to identify potential traffic operation deficiencies, within the local and regional transportation network (Short Elliott Hendrickson Inc. [SEH], 2019). The assessment reviewed potential impacts to baseline traffic conditions for roadways associated with the Project.

13.2.1 Impacts to Traffic Conditions

The increase in traffic volume anticipated for the Project would be within the volumes associated with a LOS A designation; therefore, the infrastructure has been designed to support the additional traffic volume associated with the Project. Based on Project design assumptions outlined in the transportation assessment, the following increase in traffic patterns would occur within the local and regional traffic network:

- 194 truck trips per day;
- 16 bus trips per day;
- 664 employee vehicle trips per day to the Ely and Babbitt parking lots; and
- In total, these additional trips per day equate to an additional 874 anticipated vehicles per day on local and regional transportation systems. These trips are outlined by trip type, as well as trip destination, in Table 13-2 and Table 13-3.

Table 13-2 Anticipated Daily Trips by Vehicle Type

Trip Type	Number of Trips
Truck Trips	194
Bus Trips	16
Employee Vehicle Trips	664

Table 13-3 Anticipated Daily Trips by Destination

Trip Destination	Number of Trips
Total Trips Traveling to and from the Project	874
Personal Trips to and from Babbitt Parking Lot	490
Personal Trips to and from Ely Parking Lot	144

13.2.2 Estimated Maximum Peak Hour Traffic

Vehicle trips to and from the plant site would occur throughout the day. Peak traffic hours for the Project would correlate with shift changes occurring twice daily.

13.2.3 Impacts to Regional Transportation Systems

The current AADT for TH 1, New Tomahawk Road, and CR 21 / CR 120 is outlined in Section 13.1.1. The additional trips associated with the Project are associated with truck traffic, bus traffic, and employee vehicle traffic to and from the parking lots. As a result of these additional trips, the AADT assumed as a result of the Project is 1,320 trips per day, 130 trips per day, and 2,704 trips per day for TH 1, New Tomahawk Road, and CR 21 / CR 120, respectively. The anticipated AADT identified for these regional transportation systems as a result of the Project is accommodated by the LOS A designation shown in Table 13-4. Additional explanation of how these rankings are identified can be found in the *Twin Metals Transportation Study* (SEH, 2019).

13.2.4 Impacts to Local Roads / National Forest Roads and State Forest Roads

Initial construction access to the Project area would be from NFR 1900 and NFR 1901, via TH 1 while the Project access road is being built. Access to the ventilation raise sites would be from NFR 1900 and other existing roads. Surface ownership of the access roads is a mixture of state, federal, and private and any necessary access rights will be obtained prior to usage or construction.

During construction, access to areas would need to be restricted to ensure the safety to the public and staff. While all areas that will require exclusion of the public have not yet been determined, it is anticipated that the plant site, ventilation raises, and tailings management site would require restricted access and fencing. Current National and State Forest Roads within the areas of potential ground disturbance of the plant site and tailings management site would be destroyed.

The Project access road would be a private road that it would be constructed and maintained by TMM. It is anticipated that the access road would be accessible by the public and would provide access to existing surface roads which could be used to access both state and federal surface.

The Project may require upgrading roads in the area, e.g. access to the ventilation raise sites. TMM has not proposed exclusive use to the National or State Forest system roads and proposes to pay for and develop any of the improvements required to meet safety requirements for the mine and the public, own the maintenance responsibility for the improvements during the operations, and conduct required reclamation at project closure. In addition, TMM would ensure that warning, and directional traffic signs would be installed and used as necessary.

Table 13-4 Level of Service Thresholds

Speed Limit	Truck Percentage	LOS A Service Volume (annual average daily traffic)	LOS B Service Volume (annual average daily traffic)	LOS C Service Volume (annual average daily traffic)	LOS D Service Volume (annual average daily traffic)
45	10	<3,400	3,400	8,600	13,900
50	10	<8,600	8,600	13,900	19,000
55	10	<13,900	13,900	19,000	24,200
60	10	<19,000	19,000	24,200	29,300

Notes:
Level of Service E and F are not provided in the FHWA HPMS Report
Abbreviations:
< = less than

13.2.5 Additional Infrastructure Development and Availability of Transit

Based on preliminary Project designs, the transportation assessment assumed that a 245-space parking lot and a 72-space parking lot would be in Babbitt and Ely, respectively. From the parking lots, buses would transport employees to and from the plant site. Initial design indicates three buses would report to the parking lot located in Babbitt and one bus would report to the parking lot located in Ely. In total, bus trips to and from the plant site would account for 12 trips per day. Additional parking would be available at the plant site to facilitate visitor and contractor parking.

13.2.6 Transportation Impacts Summary

The traffic study concluded that the Project would not change the LOS rating for local and regional roadways impacted by the Project. Even so, the Project plans to minimize vehicle traffic by providing buses from Babbitt and Ely to transport employees to the plant site.

The available information is adequate to make a reasoned decision about the potential for, and significance of, Project transportation impacts. Potential impacts to regional transportation systems, as identified in the transportation assessment, are characterized in the following manner:

- Timing – Traffic impacts are anticipated only during the life of the Project. These impacts are associated with the additional vehicle traffic necessary to support construction, operation, and closure activities. Additionally, NFR 1901 would be used temporarily to support the construction phase of the Project.
- Extent – The Project utilizes to the greatest extent possible the following road networks: CR 21, CR 120, and TH 1. The magnitude of impacts to these roadways would not be enough to exceed the LOS rating currently, or during the anticipated life of the Project, as identified by the traffic forecast.
- Regulatory Oversight – Public roads are subject to ongoing oversight by designated road authorities and design standards.

The transportation assessment indicates that transportation impacts would not create conditions unanticipated under the current LOS; therefore, changes to the current traffic levels are considered to be minor.

13.3 Future Scope

No future scope of work is proposed.

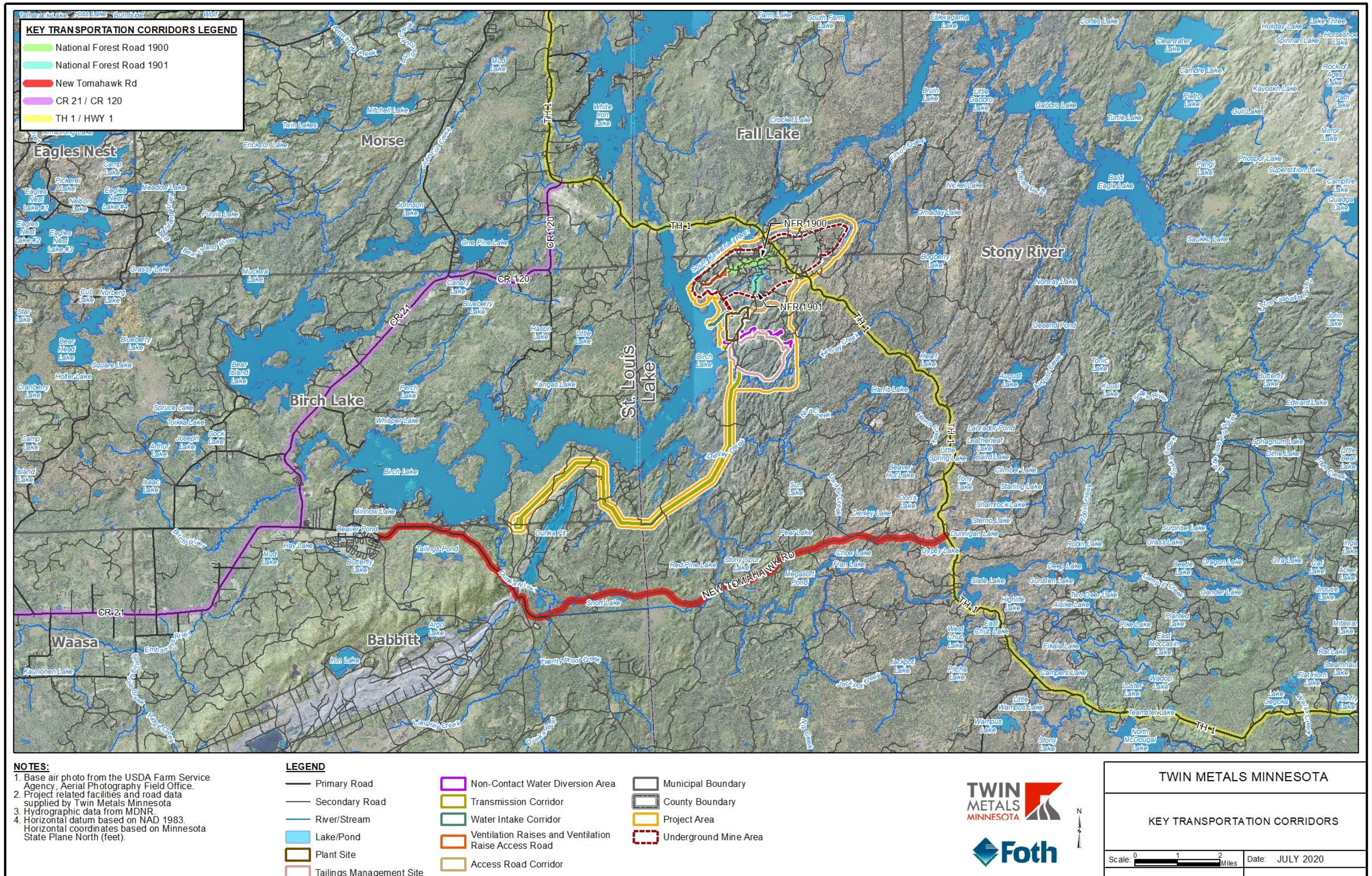

Figure 13-1 Key Transportation Corridors

14.0 CUMULATIVE POTENTIAL EFFECTS

Cumulative potential effects analysis is intended to address the combined effects of a proposed project with other projects that could contribute similar environmental effects. This is done in the context of past, present, and future projects that have overlapping impacts with the Project. For future projects, EQB applies a two-part test in determining whether a project must be considered:

- The future project is "reasonably likely to occur;"
- applications for permits have been filed with any units of government;
- detailed plans and specifications have been prepared;
- adopted comprehensive plans, zoning, or other ordinances;
- historic or forecasted development trends; or
- "Sufficiently detailed information is available about the project to contribute to the understanding of cumulative potential effects" (Minn. R., part 4410.0200, subpart 11a).

EQB guidance suggests that potential cumulative effects would occur where the "environmental footprints" of projects overlap. The areal extent of the potential project-specific effects are identified and used to define the environmental footprint of the Project. Past, present, and reasonably foreseeable future actions are then assessed based on their environmental footprints to identify overlapping areas of potential effect. These overlapping footprints are referred to as environmentally relevant areas (ERA). ERA are determined on a case-by-case basis, based on each resource and each potential impact. Similarly, the timescales of potential effects need to be considered on a case-by-case basis, based on when each resource may be impacted. Using this approach provides a framework for analyzing whether affected resources have the capacity to accommodate additional effects and to determine the potential for significance of identified cumulative effects. Cumulative potential effects are analyzed in terms of potentially affected resources, environmentally relevant areas, and impact timescale.

14.1 Context and Setting

The primary communities and projects that would potentially contribute to cumulative effects within the Mesabi Iron Range are located in the Nashwauk Uplands ECS subsection and St. Louis River Watershed. The Project is located in the Border Lakes ECS subsection and within the Rainy River Headwaters Watershed, which are the likely ERA for the Project (Figure 14-1). This ERA includes two cities, Babbitt and Ely, and the geography is dominated by public lands such as the BWCAW, SNF, state forest lands, and county lands.

The greatest potential contributor (due to areal extent) to cumulative effects within the likely ERA would be from silvicultural activities and logging. These activities have been ongoing for decades and are dispersed across the region. Mining and public resource management have been historically the primary drivers defining regional development and land use within the potential ERA for over 100 years, existing conditions are considered indicative and representative of historical mining and resource management activities.

The cumulative effects analysis in the Final NorthMet EIS is instructive, in that it considered projects using a similar approach in establishing an ERA. However, the NorthMet project is located within the Nashwauk Uplands ECS subsection and St. Louis River Watersheds where the primary development activity of the Mesabi iron range is focused.

14.2 Project-Specific Potential Effects

Because cumulative potential effects need to be assessed in comparison to the potential effects of the Project, it is important to first inventory the potential effects of the Project. These potential effects are identified and described in detail within the individual resource impact sections, i.e., Sections 4.2 through 13.2 and summarized as follows:

- Changes to surface water system, including loss or rerouting of stormwater, reduction in stream base flow, and changes in surface water quality due to non-contact water systems discharges;
- Changes to the groundwater system including effects due to mine dewatering, effects due to mine re-saturation, and effects due to either the loss of groundwater recharge or the effects of rerouting precipitation;
- Habitat loss or changes;
- NPCs, rare natural communities, and sensitive vegetative species loss or change;
- Sensitive terrestrial species loss or change;
- Visual changes due to the Project facilities;
- Noise related to the mining and processing;
- Changes to air quality from dust and GHG emissions; and
- Climate change impacts on natural sources, the built environment and human health.

There are three future scopes of work defined for water resources; fish, wildlife, and sensitive resources; and air resources in sections 6.3, 8.3, and 11.3 respectively. The results of these three future scopes of work will be used along with existing data in the SEAW data submittal to update the project specific potential effects.

14.3 Potentially Affected Resources

ERA are not defined for resources where future scopes of work are necessary to further assess potential effects and to determine appropriate Project impact areas. The results of the three identified future scopes of work will be used along with the existing data in the SEAW data submittal to update the potentially affected resources and environmentally relevant areas.

14.4 Reasonably Foreseeable Future Actions

Past impacts within the environmentally relevant areas have been accounted for in the baseline conditions in Sections 4.1 through 13.1. The baseline condition would be the result of the past and present activity that yields the present landscape.

The NorthMet project will be considered as a reasonably foreseeable future action with the potential for cumulative effects to air resources. The future scopes of work identified in Section 11.3 will inform whether the environmental footprints for potential air impacts overlap. Data developed for the NorthMet EIS and permitting will be utilized as appropriate in the analysis.

Potential mining and exploration activities within the Border Lakes ECS subsection and the South Kawishiwi River or Keeley Creek subwatersheds were considered. There were no other reasonably foreseeable mining projects identified. Exploration activities may occur periodically. However, exploration activities are highly speculative and variable as to when they would occur and as to what the extent of the activities associated with an exploration plan would contain. Encampment Minerals, Inc. has filed an exploration plan to drill exploratory borings in bedrock at four sites using the diamond core drilling method within the tailings management site. This activity would be completed in 2020 and identifies minor vegetation clearing and construction of a 400 ft (122 m) access trail to one site. These activities would be consistent with land clearing activities within the tailings management site and so no additional affects would be anticipated.

No other reasonably foreseeable actions with overlapping environmentally relevant areas were identified at this time. The results of the three identified future scopes of work will be used with the existing data in the SEAW data submittal to update the assessment of potentially affected resources, ERA, and reasonably foreseeable future actions.

14.5 Summary of Cumulative Potential Effects

Within the vicinity of the Project area (~10 miles [16 km]) there are many past human disturbances, which include:

- Gravel pits;
- A hydroelectric plant;
- Dimension stone mining operations;
- State, county, and forest road networks;
- High voltage transmission lines;
- An airport;
- Historic and current mining features such as pit lakes and stockpiles;
- Commercial timber harvest and silviculture;
- Agriculture;
- Residential (communities of Babbitt, Minnesota and Ely, Minnesota);
- Fire management; and
- Recreation.

These disturbances are accounted for within the baseline conditions of the Sections 4.1 through 13.1. The identified potentially affected resources, environmentally relevant areas, and timescale are listed in Table 14-1.

For a number of the potentially affected resources, the environmentally relevant areas could not be determined due to the need to complete additional scopes of work. The results of the three identified future scopes of work will be used with the existing data in the SEAW data submittal to update the assessment of potentially affected resources, ERA, and reasonably foreseeable future actions.

Table 14-1 Cumulative Potential Effects Summary

Affected Resource	Timescale	Environmentally relevant area	Reasonably Foreseeable Future Actions
Surface water quality	Temporary during Project construction, operations, and closure	Birch Lake and lower Keeley Creek	None
Surface water hydrology	Temporary during Project construction, operations, and closure	Future work scope necessary - outlined in Section 6.3.1	To be defined based on future work scope
Groundwater quality	Temporary during Project closure	Future work scope necessary - outlined in Section 6.3.2	To be defined based on future work scope
Groundwater hydrogeology	Temporary during Project construction, operations, and closure Permanent - dry stack facility recharge	Future work scope necessary - outlined in Section 6.3.2	To be defined based on future work scope
Wetlands	Temporary during Project construction, operations, and closure - Indirect Impacts Permanent - Direct Impacts	Project area	None
Habitat	Temporary during Project construction, operations, and closure	Future work scope necessary - outlined in Section 8.3.1	To be defined based on future scope
High quality NPCs, rare natural communities, and sensitive vegetative species	Permanent or temporary based on specific community or species, future work necessary	Future work scope necessary - outlined in Section 8.3.1	To be defined based on future work scope
Sensitive terrestrial species	Permanent or temporary based on specific community or species, future work necessary	Future work scope necessary - outlined in Section 8.3.2	To be defined based on future work scope
Noise	Temporary during Project construction, operations, and closure	Project area	None
Visual	Temporary during Project construction, operations, and closure - all other Permanent - dry stack facility	Project area, portions of the surface of Birch Lake and a portion of the western shore of Birch Lake	None

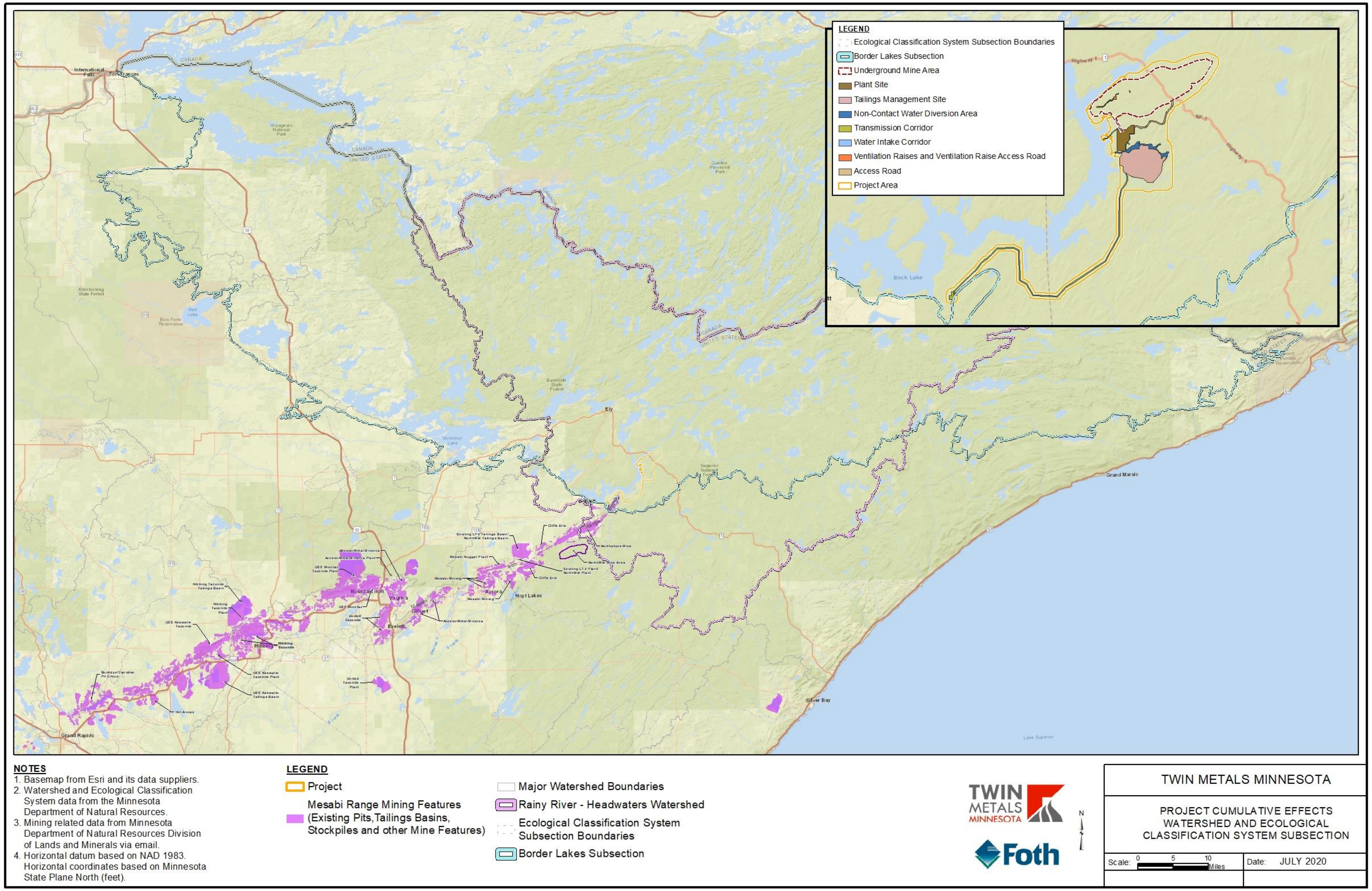

Figure 14-1 Project Cumulative Effects Watersheds and Ecological Classification System Subsection

15.0 OTHER POTENTIAL ENVIRONMENTAL EFFECTS

The SEAW data submittal provides information that is considered within the Minnesota Environmental Policy Act scoping process. Additional information will be developed in support of the Minnesota Environmental Policy Act and National Environmental Policy Act processes. These areas are listed in the subsections that follow.

15.1 Recreation

Recreation is an important activity on private and public lands within the region. It is tied largely to the quality and accessibility of lands. Recreation within the Project area or within 25 miles (40.2 km) of the Project area may include, but are not limited to:

- Boating, canoeing, and camping in the BWCAW and other local, state, and federal lands;
- Hunting and fishing;
- Year-round recreation, including downhill skiing, snowmobiling, off-highway vehicle (OHV) use, mountain biking, hiking, dispersed camping, and golf;
- Recreational trails;
- Water oriented commercial businesses (e.g., resorts; houseboat rental; fish guiding; other); and
- Lake shoreland residences.

Within 1 mile (0.6 km) of the Project area there are two campgrounds:

- South Kawishiwi River Campground – northeast of Project and
- Birch Lake Campground – southwest of the Project on the west shore of Birch Lake.

In addition to the campgrounds, two backcountry camping sites are located within 1,000 ft (300 m) of the Project area on the eastern shore of Birch Lake – these campsites are accessible by any type of watercraft. Additionally, two USFS designated moderately developed trails, T5-1901a and T5-1904, are located within the Project area.

A Grant-in-Aid snowmobile trail, which currently runs through the footprint of the transmission corridor, is maintained by the Ely Igloos Snowmobile Club. The trail crosses the footprint of the transmission corridor in NWNE Section 29, T61N, R11W.

It is anticipated that the Project will not have a significant impact on recreation as most recreation occurs outside the Project area and no impacts are planned which would impact ingress or egress to recreational facilities in the area.

Studies will be conducted to document the types and levels of recreation near the Project as well as the potential effects to recreation as a result of changes to the quality and accessibility of the environment. These studies will include direct effects to recreation resulting from the construction, operation, and closure of the Project and will consider the potential reduction in acreage of recreational options for public use. The analysis will also include indirect effects to recreation in areas surrounding the Project area due to noise, dust, visual impacts, or other Project-related impacts. The evaluation of effects will be based on a comparison to state and federal land and recreation management plans.

15.2 Socioeconomics

Socioeconomic consequences of the Project are expected to occur on a regional scale. Socioeconomics includes demographic characteristics of the 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 cultural and economic characteristics of subsistence activities of Native American populations. Further studies will be conducted to document the socioeconomic effects of the Project.

The analysis will also include the collection of baseline data and an evaluation of potential impacts to state-defined areas of concern for environmental justice. These areas include tribal areas, and census tracts with higher concentrations of low-income residents and people of color.

15.3 Vibration

Humans can feel ground vibration at levels well below thresholds that would cause damage to property. Ground vibration evaluation would consider two aspects: an environmental or acceptable human (annoyance) threshold, and a structural damage threshold. Vibration from blasting activities would be subject to ongoing regulatory controls through the requirements of Minn. R., part 6132.2900, subpart 2. Further studies will be conducted to document the vibration effects of the Project.

15.4 Wilderness

The BWCAW is an important resource area within the region and is linked to its accessibility and the quality of the environment. TMM recognizes the importance of the BWCAW and the sensitivity around its proximity to the Project. The Project is located outside of the BWCAW and does not propose changes that would alter the accessibility to the BWCAW. A report that will combine the existing information with the results of the identified future scopes of work for air resources; fish, wildlife, and sensitive resources; and water resources will be generated that documents the potential effects to the BWCAW due to potential changes to the quality and accessibility of the environment within the BWCAW.

16.0 RESPONSIBLE GOVERNMENTAL UNIT CERTIFICATION

I hereby certify that:

- The information contained in this document is accurate and complete to the best of my knowledge.
- The EAW describes the complete Project; there are no other projects, stages, or components other than those described in this document, which are related to the Project as connected actions or phased actions, as defined at Minn. R., part 4410.0200, subparts 9c and 60, respectively.
- Copies of this EAW are being sent to the entire EQB distribution list.

Signature ________________________________ Date ____________________

Title ________________________________

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APPENDIX A

TAX PARCEL NUMBER / OWNERSHIP

Table A1 Tax Parcel Number / Ownership

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6011-06310	6	60	11	GOVT LOT 4	USA	USA		0.585
20-6011-06983	6	60	11	GOVT LOT 5	USA	USA		17.415
20-6011-06984	6	60	11	GOVT LOT 6	USA	USA		14.502
20-6011-06986	6	60	11	GOVT LOT 8	USA	USA		23.748
20-6011-06987	6	60	11	GOVT LOT 9	USA	STATE OF MINNESOTA		26.379
20-6011-06988	6	60	11	GOVT LOT 10	USA	STATE OF MINNESOTA		0.699
20-6011-06990	6	60	11	GOVT LOT 16	USA	UNCLEAR: STATE OF MN?		0.533
20-6011-06991	6	60	11	GOVT LOT 17	STATE OF MINNESOTA	UNCLEAR: STATE OF MN?		3.968
20-6111-02250	2	61	11	GOVT LOT 3	USA	USA		8.548
20-6111-02310	2	61	11	GOVT LOT 4	USA	USA		35.712
20-6111-02370	2	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		8.517
20-6111-03010	3	61	11	GOVT LOT 1	STATE OF MINNESOTA	STATE OF MINNESOTA		34.279
20-6111-03070	3	61	11	GOVT LOT 2	USA	USA		38.292
20-6111-03130	3	61	11	SW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.99
20-6111-03190	3	61	11	SE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		30.964
20-6111-03250	3	61	11	GOVT LOT 3	STATE OF MINNESOTA	STATE OF MINNESOTA		36.042
20-6111-03310	3	61	11	GOVT LOT 4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.072
20-6111-03370	3	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.176
20-6111-03430	3	61	11	SE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.352
20-6111-03490	3	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.725
20-6111-03550	3	61	11	NW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.219
20-6111-03610	3	61	11	SW 1/4 OF SW 1/4	USA	USA		40.113
20-6111-03670	3	61	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		19.662

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6111-03730	3	61	11	NE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		2.191
20-6111-03790	3	61	11	NW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		21.69
20-6111-04010	4	61	11	GOVT LOT 1	USA	USA		36.381
20-6111-04070	4	61	11	GOVT LOT 2	USA	USA		36.033
20-6111-04130	4	61	11	SW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.884
20-6111-04190	4	61	11	SE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.677
20-6111-04250	4	61	11	GOVT LOT 3	STATE OF MINNESOTA	STATE OF MINNESOTA		37.135
20-6111-04310	4	61	11	GOVT LOT 4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.764
20-6111-04370	4	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.942
20-6111-04430	4	61	11	SE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.685
20-6111-04490	4	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.354
20-6111-04550	4	61	11	NW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.068
20-6111-04610	4	61	11	SW 1/4 OF SW 1/4	USA	Goldie I. Foster; a/k/a Goldie I. Parker; a/k/a Goldie I. Mayer; and Walter B. Foster (17/81)	"Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)"	40
20-6111-04670	4	61	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.551
20-6111-04730	4	61	11	NE 1/4 OF SE 1/4	USA	USA		40.481
20-6111-04790	4	61	11	NW 1/4 OF SE 1/4	USA	USA		40.199
20-6111-04850	4	61	11	SW 1/4 OF SE 1/4	USA	USA		40.333
20-6111-04910	4	61	11	SE 1/4 OF SE 1/4	USA	USA		40.256
20-6111-05010	5	61	11	GOVT LOT 1	USA	USA		38.149
20-6111-05190	5	61	11	SE 1/4 OF NE 1/4	USA	USA		39.116

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6111-05490	5	61	11	NE 1/4 OF SW 1/4	USA	USA		39.728
20-6111-05670	5	61	11	SE 1/4 OF SW 1/4	USA	USA		37.519
20-6111-05730	5	61	11	NE 1/4 OF SE 1/4	USA	USA		40.235
20-6111-05790	5	61	11	NW 1/4 OF SE 1/4	USA	USA		40.151
20-6111-05850	5	61	11	SW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.744
20-6111-05910	5	61	11	SE 1/4 OF SE 1/4	USA	Goldie I. Foster; a/k/a Goldie I. Parker; a/k/a Goldie I. Mayer; and Walter B. Foster (17/81)	"Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)"	40.293
20-6178-00020	5	61	11	OUTLOT B	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.214
20-6178-00030	5	61	11	OUTLOT C	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.771
20-6178-00040	5	61	11	OUTLOT D	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.73
20-6178-00050	5	61	11	OUTLOT E	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.303
20-6178-00060	5	61	11	OUTLOT F	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.643
20-6178-00080	5	61	11	OUTLOT H	SOUTH KAWISHIWI ASSOCIATION LLC	USA		65.553
20-6178-00090	5	61	11	OUTLOT I	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.944

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6178-00100	5	61	11	OUTLOT J	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.038
20-6178-00110	5	61	11	OUTLOT K	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.089
20-6178-00120	5	61	11	OUTLOT L	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.636
20-6178-00130	5	61	11	OUTLOT M	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3
20-6178-00140	5	61	11	OUTLOT N	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.28
20-6178-00150	5	61	11	OUTLOT O	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.604
20-6178-00160	5	61	11	OUTLOT P	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.872
20-6178-00170	5	61	11	OUTLOT Q	SOUTH KAWISHIWI ASSOCIATION LLC	USA		4.342
20-6178-00180	5	61	11	OUTLOT R	SOUTH KAWISHIWI ASSOCIATION LLC	USA		63.415
20-6178-01050	5	61	11	LOT 5 BLOCK 1	CUKUROVA CIHAN + GEBO ANN	USA		1.653
20-6178-01060	5	61	11	LOT 6 BLOCK 1	BRISTOL LINDA J TRUST 1/24/10	USA		1.631
20-6178-01070	5	61	11	LOT 7 BLOCK 1	PORTMAN JEFFREY S	USA		1.062
20-6178-01080	5	61	11	LOT 8 BLOCK 1	DEVANEY DANIEL S REV TRUST	USA		0.932
20-6178-01090	5	61	11	LOT 9 BLOCK 1	REUTTER JOHN R & HARRIET H	USA		1.324

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6178-01100	5	61	11	LOT 10 BLOCK 1	RIDNOUR BRADLEY EDWARD REV TRUST	USA		1.028
20-6178-01110	5	61	11	LOT 11 BLOCK 1	VALLEZ MARILYN R TRUST 12/2/88	USA		1.097
20-6178-01120	5	61	11	LOT 12 BLOCK 1	BERKEMEYER DONALD W & MARY B	USA		1.061
20-6178-01130	5	61	11	LOT 13 BLOCK 1	THERRIEN STEVEN M & DEVANEY DEBORAH	USA		1.414
20-6178-01140 and 20-6178-01141	5	61	11	1/2 INTEREST (EACH OWN) LOT 14 BLOCK 1	HOFFMAN FAMILY REAL ESTATE TRUST AND HOFFMAN TRUST ET AL	USA		1.657
20-6178-01150	5	61	11	LOT 15 BLOCK 1	CHELESNIK FAMILY TRUST	USA		1.418
20-6178-01160	5	61	11	LOT 16 BLOCK 1	RUSSELL MARILYN SOLBERG	USA		0.94
20-6178-01170	5	61	11	LOT 17 BLOCK 1	MITCHUM PHILLIP L & COLLEEN M	USA		0.879
20-6178-01180 and 20-6178-01181 and 20-6178-01182	5	61	11	LOT 18 BLOCK 1 - 1/3 UDI (each own)	HELMER MARK AND CLARK RICHARD C AND JOHNSON JEANINE ET AL	USA		0.955
20-6178-01190	5	61	11	LOT 19 BLOCK 1	TEICHERT MICHAEL R & BARBARA J	USA		1.245
20-6178-01200	5	61	11	LOT 20 BLOCK 1	CHILDS ANDREA S	USA		1.5
20-6178-01210	5	61	11	LOT 21 BLOCK 1	HENRY PATRICK M & LUCILLE B	USA		1.232
N/A	5	61	11	Road right of way	The South Kawishiwi Association, LLC	USA		13.165
20-6178-00070	6	61	11	OUTLOT G	SOUTH KAWISHIWI ASSOCIATION LLC	USA		8.715
20-6178-01230	6	61	11	LOT 23 BLOCK 1	HIRSCH DUANE C & TONI L	USA		1.274

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6178-01240	6	61	11	LOT 24 BLOCK 1	BOLLIS CHRISTOPHER J & GAIL M	USA		1.392
20-6178-01250	6	61	11	LOT 25 BLOCK 1	FROEMLING ROBERT A TRUST #12-12 +	USA		1.247
20-6111-07010	7	61	11	GOVT LOT 1	USA	USA		1.78
20-6111-07011	7	61	11	GOVT LOT 12	USA	USA		0.001
20-6111-08010	8	61	11	NE 1/4 OF NE 1/4	USA	Goldie I. Foster; a/k/a Goldie I. Parker; a/k/a Goldie I. Mayer; and Walter B. Foster (17/81)	"Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)"	40.695
20-6111-08070	8	61	11	NW 1/4 OF NE 1/4	USA	USA		37.278
20-6111-08130	8	61	11	SW 1/4 OF NE 1/4	USA	USA		33.747
20-6111-08190	8	61	11	SE1/4 OF NE1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	40.457
20-6111-08250	8	61	11	GOVT LOT 1	USA	USA		8.937
20-6111-08310	8	61	11	GOVT LOT 2	USA	USA		27.191
20-6111-08430	8	61	11	GOVT LOT 4	USA	USA		0.759
20-6111-08490	8	61	11	LOT 5	PINE BRANCH LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	16.312
20-6111-08730	8	61	11	NE1/4 OF SE1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	40.218
20-6111-08790	8	61	11	NW 1/4 OF SE 1/4	USA	USA		31.46
20-6111-08850	8	61	11	SW 1/4 OF SE 1/4	LAKE COUNTY	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	29.269
20-6111-08910	8	61	11	SE1/4 OF SE1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	39.98
20-6111-09010	9	61	11	NE 1/4 OF NE 1/4	USA	USA		40.065
20-6111-09070	9	61	11	NW 1/4 OF NE 1/4	USA	USA		40.016
20-6111-09130	9	61	11	SW 1/4 OF NE 1/4	USA	USA		40.05
20-6111-09190	9	61	11	SE 1/4 OF NE 1/4	USA	USA		40.1

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6111-09250	9	61	11	NE 1/4 OF NW 1/4	USA	USA		40.169
20-6111-09310	9	61	11	NW 1/4 OF NW 1/4	USA	GOLDIE I. FOSTER; A/K/A GOLDIE I. PARKER; A/K/A GOLDIE I. MAYER; AND WALTER B. FOSTER (17/81)	"Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)"	40.151
20-6111-09370	9	61	11	SW1/4 OF NW1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	40.37
20-6111-09430	9	61	11	SE 1/4 OF NW 1/4	USA	USA		40.236
20-6111-09490	9	61	11	NE 1/4 OF SW 1/4	USA	USA		40.265
20-6111-09550	9	61	11	NW 1/4 OF SW 1/4	USA	USA		40.399
20-6111-09610	9	61	11	SW 1/4 OF SW 1/4	USA	USA		40.429
20-6111-09670	9	61	11	SE 1/4 OF SW 1/4	USA	USA		40.294
20-6111-09730	9	61	11	NE 1/4 OF SE 1/4	USA	USA		40.134
20-6111-09790	9	61	11	NW 1/4 OF SE 1/4	USA	USA		40.084
20-6111-09850	9	61	11	SW 1/4 OF SE 1/4	USA	USA		40.118
20-6111-09910	9	61	11	SE 1/4 OF SE 1/4	USA	USA		40.168
20-6111-10250	10	61	11	NE 1/4 OF NW 1/4	USA	USA		2.284
20-6111-10310	10	61	11	NW 1/4 OF NW 1/4	USA	USA		39.863
20-6111-10370	10	61	11	SW 1/4 OF NW 1/4	USA	USA		38.766
20-6111-10490	10	61	11	NE 1/4 OF SW 1/4	USA	USA		0.404
20-6111-10550	10	61	11	NW 1/4 OF SW 1/4	USA	USA		38.129
20-6111-10610	10	61	11	SW 1/4 OF SW 1/4	USA	USA		39.937
20-6111-10670	10	61	11	SE 1/4 OF SW 1/4	USA	USA		16.021
20-6111-15250	15	61	11	NE 1/4 OF NW 1/4	USA	USA		20.834

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6111-15310	15	61	11	NW 1/4 OF NW 1/4	USA	USA		39.903
20-6111-15370	15	61	11	SW 1/4 OF NW 1/4	USA	USA		39.886
20-6111-15430	15	61	11	SE 1/4 OF NW 1/4	USA	USA		20.845
20-6111-15490	15	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		20.855
20-6111-15550	15	61	11	NW 1/4 OF SW 1/4	USA	USA		39.868
20-6111-15610	15	61	11	SW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.85
20-6111-15670	15	61	11	SE 1/4 OF SW 1/4	USA	USA		20.866
20-6111-16010	16	61	11	NE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.126
20-6111-16070	16	61	11	NW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.133
20-6111-16130	16	61	11	SW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.076
20-6111-16190	16	61	11	SE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.069
20-6111-16250	16	61	11	NE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.215
20-6111-16310	16	61	11	NW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.173
20-6111-16370	16	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.049
20-6111-16430	16	61	11	SE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.092
20-6111-16490	16	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.027
20-6111-16550	16	61	11	NW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.035
20-6111-16610	16	61	11	SW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.978
20-6111-16670	16	61	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.97
20-6111-16730	16	61	11	NE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.012
20-6111-16790	16	61	11	NW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.019
20-6111-16850	16	61	11	SW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.962
20-6111-16910	16	61	11	SE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.955
20-6111-17010	17	61	11	NE 1/4 OF NE 1/4	USA	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	37.299

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6111-17070	17	61	11	GOVT LOT 1	USA	ST. CROIX LUMBER CO (1/2)	USA	11.701
20-6111-17190	17	61	11	SE 1/4 OF NE 1/4	USA	USA		30.413
20-6111-17730	17	61	11	GOVT LOT 8	USA	USA		29.309
20-6111-17910	17	61	11	SE 1/4 OF SE 1/4	USA	USA		30.409
20-6111-20010	20	61	11	NE 1/4 OF NE 1/4	USA	USA		33.873
20-6111-20070	20	61	11	NW 1/4 OF NE 1/4	USA	USA		1.508
20-6111-20130	20	61	11	SW 1/4 OF NE 1/4	USA	USA		8.6
20-6111-20190	20	61	11	SE 1/4 OF NE 1/4	USA	USA		22.24
20-6111-20730	20	61	11	NE 1/4 OF SE 1/4	USA	USA		19.668
20-6111-20790	20	61	11	NW 1/4 OF SE 1/4	USA	USA		10.749
20-6111-20850	20	61	11	SW 1/4 OF SE 1/4	USA	USA		11.479
20-6111-20910	20	61	11	SE 1/4 OF SE 1/4	USA	USA		18.937
20-6111-21010	21	61	11	NE 1/4 OF NE 1/4	USA	USA		30.789
20-6111-21070	21	61	11	NW 1/4 OF NE 1/4	USA	USA		36.226
20-6111-21250	21	61	11	NE 1/4 OF NW 1/4	USA	USA		30.167
20-6111-21310	21	61	11	NW 1/4 OF NW 1/4	USA	USA		30.161
20-6111-22250	22	61	11	NE 1/4 OF NW 1/4	USA	USA		10.838
20-6111-22310	22	61	11	NW 1/4 OF NW 1/4	USA	USA		29.495
20-6111-29010	29	61	11	NE 1/4 OF NE 1/4	USA	USA		18.149
20-6111-29070	29	61	11	NW 1/4 OF NE 1/4	USA	USA		12.188
20-6111-29130	29	61	11	SW 1/4 OF NE 1/4	USA	USA		13.048
20-6111-29190	29	61	11	SE 1/4 OF NE 1/4	USA	USA		17.394
20-6111-29670	29	61	11	SE 1/4 OF SW 1/4	USA	USA		9.273
20-6111-29730	29	61	11	NE 1/4 OF SE 1/4	USA	USA		7.967

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
20-6111-29790	29	61	11	NW 1/4 OF SE 1/4	USA	USA		26.6
20-6111-29850	29	61	11	SW 1/4 OF SE 1/4	USA	USA		25.422
20-6111-31190	31	61	11	SE 1/4 OF NE 1/4	USA	USA		8.398
20-6111-31490	31	61	11	GOVT LOT 8	USA	USA		0.292
20-6111-31610	31	61	11	GOVT LOT 12	USA	USA		4.147
20-6111-31670	31	61	11	GOVT LOT 13	USA	USA		27.057
20-6111-31730	31	61	11	NE 1/4 OF SE 1/4	USA	USA		27.288
20-6111-31790	31	61	11	NW 1/4 OF SE 1/4	USA	USA		17.407
20-6111-31850	31	61	11	GOVT LOT 14	USA	USA		18.78
20-6111-31910	31	61	11	GOVT LOT 15	USA	USA		0.532
20-6111-32070	32	61	11	NW 1/4 OF NE 1/4	USA	USA		4.493
20-6111-32250	32	61	11	NE 1/4 OF NW 1/4	USA	USA		29.383
20-6111-32310	32	61	11	NW 1/4 OF NW 1/4	USA	USA		0.868
20-6111-32370	32	61	11	SW 1/4 OF NW 1/4	USA	USA		30.674
20-6111-32430	32	61	11	SE 1/4 OF NW 1/4	USA	USA		14.414
20-6111-32550	32	61	11	NW 1/4 OF SW 1/4	USA	USA		4.698
20-6178-01220	5 & 6	61	11	LOT 22 BLOCK 1	SEEKER MICHAEL & REBECCA C	USA		1.473
28-6278-00010	32	62	11	OUTLOT A	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.205
28-6278-00190	32	62	11	OUTLOT S	SOUTH KAWISHIWI ASSOCIATION LLC	USA		5.007
28-6278-00200	32	62	11	OUTLOT T	SOUTH KAWISHIWI ASSOCIATION LLC	USA		11.807

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
28-6278-00210	32	62	11	OUTLOT U	SOUTH KAWISHIWI ASSOCIATION LLC	USA		9.324
28-6278-01010	32	62	11	LOT 1 BLOCK 1	ZGONC MICHAEL J & JENNIFER L	USA		1.029
28-6278-01020	32	62	11	LOT 2 BLOCK 1	BUSTA MARK W & BARBARA A	USA		1.137
28-6278-01030	32	62	11	LOT 3 BLOCK 1	DEVANEY DEBRA J	USA		1.325
28-6278-01040	32	62	11	LOT 4 BLOCK 1	PICKFORD JW FAMILY TRUST	USA		1.045
28-6211-33130	33	62	11	GOVT LOT 2	USA	USA		4.99
28-6211-33190	33	62	11	SE1/4 OF NE1/4	USA	USA		26.91
28-6211-33490	33	62	11	GOVT LOT 7	USA	USA		15.651
28-6211-33550	33	62	11	GOVT LOT 6	USA	USA		49.997
28-6211-33670	33	62	11	SE 1/4 OF SW 1/4	USA	RGGS Land & Minerals Ltd LP		40.757
28-6211-33730	33	62	11	NE 1/4 OF SE 1/4	USA	USA		39.67
28-6211-33790	33	62	11	NW 1/4 OF SE 1/4	USA	RGGS Land & Minerals Ltd LP		37.127
28-6211-33850	33	62	11	SW 1/4 OF SE 1/4	USA	USA		40.175
28-6211-33910	33	62	11	SE 1/4 OF SE 1/4	USA	RGGS Land & Minerals Ltd LP		39.384
28-6211-34010	34	62	11	NE 1/4 OF NE 1/4	USA	FRANCONIA MINERALS CORPORATION INC. (1/2)	Hector Iron Co. (1/2)	10.034
28-6211-34070	34	62	11	NW 1/4 OF NE 1/4	USA	FRANCONIA MINERALS CORPORATION INC. (1/2)	Hector Iron Co. (1/2)	0.24
28-6211-34130	34	62	11	SW 1/4 OF NE 1/4	USA	USA		33.857
28-6211-34190	34	62	11	SE 1/4 OF NE 1/4	USA	USA		38.731
28-6211-34370	34	62	11	SW 1/4 OF NW 1/4	USA	USA		31.828
28-6211-34430	34	62	11	SE 1/4 OF NW 1/4	USA	USA		23.993

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
28-6211-34490	34	62	11	NE 1/4 OF SW 1/4	USA	USA		38.934
28-6211-34550	34	62	11	NW 1/4 OF SW 1/4	USA	USA		38.66
28-6211-34610	34	62	11	SW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		38.645
28-6211-34670	34	62	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		38.919
28-6211-34730	34	62	11	NE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		38.889
28-6211-34790	34	62	11	NW 1/4 OF SE 1/4	USA	USA		38.68
28-6211-34850	34	62	11	SW 1/4 OF SE 1/4	USA	USA		38.928
28-6211-34910	34	62	11	SE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.173
28-6211-35070	35	62	11	NW 1/4 OF NE 1/4	USA	USA		10.157
28-6211-35130	35	62	11	SW1/4 OF NE1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		37.757
28-6211-35250	35	62	11	NE 1/4 OF NW 1/4	USA	USA		25.002
28-6211-35310	35	62	11	NW 1/4 OF NW 1/4	USA	USA		20.265
28-6211-35370	35	62	11	SW1/4 OF NW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.037
28-6211-35430	35	62	11	SE1/4 OF NW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.196
28-6211-35490	35	62	11	NE1/4 OF SW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.684
28-6211-35550	35	62	11	NW 1/4 OF SW 1/4	USA	USA		40.347
28-6211-35610	35	62	11	SW1/4 OF SW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.071
28-6211-35670	35	62	11	SE1/4 OF SW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		34.599
28-6211-35790	35	62	11	NW1/4 OF SE1/4	TWIN METALS MINNESOTA LLC	RGGS LAND & MINERALS LTD LP		21.677
28-6211-35850	35	62	11	SW 1/4 OF SE 1/4	USA	USA		2.175
105-0060-00010	1	60	12	GOVT LOT 1	USA	Rendrag Inc.		29.23
105-0060-00010	1	60	12	GOVT LOT 2	USA	Longyear Mesaba		25.821
105-0060-00010	1	60	12	GOVT LOT 3	USA	Rendrag Inc.		8.904
105-0060-00370	3	60	12	LOT 3	CLIFFS ERIE LLC	DUNKA MINERALS CORP. (1/3)	"KMK Dunka Inc. (1/3) DRM Minerals Corp. (1/3)"	5.512

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
105-0060-00380	3	60	12	N 660 FT OF W 660 OF GOVT LOT 4	ALLETE INC	STATE OF MN (1/3)	"Dunka Minerals Corp. (2/9) KMK Dunka Inc. (2/9) DRM Minerals Corp. (2/9)"	9.997
105-0060-00382	3	60	12	GOVT LOT 4 EX N 660 FT OF W 660 FT	FRANCONIA MINERALS (US) LLC	STATE OF MN (1/3)	"Dunka Minerals Corp. (2/9) KMK Dunka Inc. (2/9) DRM Minerals Corp. (2/9)"	24.544
105-0060-00490	4	60	12	NE1/4 OF NE1/4	USA	RENDRAG INC.		3.996
610-0011-03620	25	61	12	Government Lot 4, Section 25, Township 61 North, Range 12, EXCEPT that part beginning at a point where the southerly line of Government Lot 4 meets the easterly shoreline of Bobs Bay; thence East 400 feet; thence North 470 feet; thence West 400 feet; thence Southerly to the point of beginning.	RENDFIELD LAND CO INC	STATE OF MINNESOTA		0.041
610-0011-03630	25	61	12	"That part of the NW1/4 of SW1/4 Section 25 Township 61 North Range 12 West lying SE'ly of the following described ""Lines A and B"": Commencing at the NW corner of the SE1/4 of NW1/4, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on the Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft; thence SE'ly along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft to the point of tangency and the point of beginning of ""LIne A"": ""Line A"" - thence N 48 degrees 37 minutes 29 seconds E a distance of 90.93 ft; thence N 00 degrees 00 minutes 00 seconds W a distance of 66.00 ft; thence N 28 degrees 00 minutes 12 seconds E a distance of 568.9 ft to the N line of said NW1/4 of SW1/4, Section 25, and there terminating. ""Line B"" - beginning at the point of beginning of the above designated ""Line A""; thence S 02 degrees 31 minutes 39 seconds W a distance of 694.58 ft to the S line of said NW1/4 of SW1/4, and there terminating. "	ALLETE INC	DU NORD LAND CO (1/2)	"Frederic Paine Worthen/Frederic P. Worthen 1980 Trust (1/22) Anna Welles Paines Williams/Sarah Townsend Williams (1/22) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Roger Townsend Williams (1/60) Geoffrey Paine Williams (1/60) Joel Hooker Williams (1/60) Sarah Townsend Williams (1/60) Susan Barton Williams (1/60) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) State of Minnesota (391/2112)"	14.995

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03631	25	61	12	That part of the NW¼ of SW¼, Section 25 in Township 61 North, Range 12 West lying N'ly, NE'ly and NW'ly of the following described line: Beginning at the NW corner of SE¼ of NW¼, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on the Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft.; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft., central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft. to the point of tangency ; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft.; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft., central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft., central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft. to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft.; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft., central angle of 43 degrees 11 minutes 47 seconds , a distance of 251 . 05 ft. to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433. 00 ft., central angle of 22 degrees 33 minutes 42 seconds , a distance of 564.28 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft., central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft., central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft., central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft., central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 feet, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft.; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft.; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft., central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft. to the point of tangency; thence N 48 degrees 37 minutes 29 seconds E a distance of 90.93 ft.; thence N 00 degrees 00 minutes 00 seconds W a distance of 66.00 ft., thence N 28 degrees 00 minutes 12 seconds E a distance of 568.9 ft. to the N line of said NW¼ of SW¼, Section 25, and there terminating.	RENDFIELD LAND CO INC	DU NORD LAND CO (1/2)	"Frederic Paine Worthen/Frederic P. Worthen 1980 Trust (1/22) Anna Welles Paines Williams/Sarah Townsend Williams (1/22) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Roger Townsend Williams (1/60) Geoffrey Paine Williams (1/60) Joel Hooker Williams (1/60) Sarah Townsend Williams (1/60) Susan Barton Williams (1/60) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) State of Minnesota (391/2112)"	2.48

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03632	25	61	12	"That part of the NW1/4 of the SW1/4 lying S'ly and W'ly of the following described line; Commencing at the NW corner of the SE1/4 of NW1/4, Section 26, Township 61 North, Range 12 West; thence S 76 degrees 38 minutes 05 seconds E bearing based on Saint Louis County Tansverse Mercardor 1996 Projection, a distance of 268.32 ft; thence SE'ly along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E, a distance of 486.88 ft; thence SE'ly along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E, a distance of 143.72 ft; thence SE'ly along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft, cetral angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve; thene SE'ly along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 66 degrees 19 minutes 22 seconds, a distance of 385.46 ft to the point of beginning of the line to be described; thence continuing SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 66 degrees 19 minutes 22 seconds, a distance of 385.46 ft to the point of beginning of the line to be described; thence continuing SE'ly, along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 24 degrees 29 minutes 10 seconds, a distance of 142.31 ft; thence S 50 degrees 05 minutes 02 seconds E, a distance of 98.03 ft; thence SE'ly along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft; thence S 02 degrees 31 minutes 39 seconds W, a distance of 694.58 ft to the S line of said NW1/4 of SW1/4 and said line there terminating."	FRANCONIA MINERALS (US) LLC	DU NORD LAND CO (1/2)	"Frederic Paine Worthen/Frederic P. Worthen 1980 Trust (1/22) Anna Welles Paines Williams/Sarah Townsend Williams (1/22) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Roger Townsend Williams (1/60) Geoffrey Paine Williams (1/60) Joel Hooker Williams (1/60) Sarah Townsend Williams (1/60) Susan Barton Williams (1/60) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) State of Minnesota (391/2112)"	4.79

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03640	25	61	12	"SW1/4 of SW1/4 Section 25 in Township 61 North Range 12 West of the Fourth Principal Meridian EXCEPT that part of the SW1/4 of SW1/4 Section 25 Township 61 North Range 12 West lying S'ly and W'ly of ""Line A"" to be described and 300.00 ft NW'ly of, measured at right angles to and parallel with ""Line B"" to be described. ""Line A"" and ""Line B"" are described as follows: ""Line A"" Commencing at the NW corner of the SE1/4 of NW1/4 Section 26 Township 61 North Range 12 West; thence S 76 degrees 38 minutes 05 seconds E bearing based on Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'y along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, cental angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve, thence SE'ly along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft; thence SE'ly along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft to a point; thence S 02 degrees 31 minutes 39 seconds W, a distance of 694.58 ft to the N line of said SW1/4 of SW1/4 and also being the point of beginning of the line to be decribed; thence continuing S 02 degrees 31 minutes 39 seconds W, a distance of 256.53 ft; thence SW'ly along a tangential curve concave to the NW having a radius of 1134.00 ft, central angle of 30 degrees 15 minutes 34 seconds, a distance of 598.90 ft to the point of reverse curve; thence SW'ly, S'ly and SE'ly, along said reverse curve concave to the E having a radius of 333.00 ft, cental angle of 60 degrees 16 minutes 05 seconds, a distance of 350.27 ft to a point being 300.00 ft NW'ly of, measured at right angles to and parallel with ""Line B"" to be described and said ""Line A"" there terminating. ""Line B"" Commencing at the SW corner of said Section 25; thence S 88 degrees 33 minutes 39 seconds E along the S line of said Section 25, a distance of 334.90 ft to the beginning of the line to be described; thence N 14 degrees 59 minutes 50 seconds E, a distance of 70.97 ft; thence N 26 degrees 29 minutes 50 seconds E, a distance of 1393.23 ft to the N line of said SW1/4 of SW1/4 and said ""Line B"" there terminating. The side line of said 300.00 ft wide strip terminates on said ""Line A"" and the S line of said SW1/4 of SW1/4. SE1/4 of SE1/4 Section 35 in Township 61 North Range 12 West of the Fourth Principal Meridian."	ALLETE INC	USA		22.881

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03641	25	61	12	"That part of the SW1/4 of SW1/4, Section 25, Township 61 North, Range 12 West, lying S'ly and W'ly of ""Line A"" to be described and 300.00 ft NW'ly of, measured at right angles to and parallel with ""Line B"" to be described. ""Line A"" and ""Line B"" are described as follows: ""Line A"" Commencing at the NW corner of the SE1/4 of NW1/4, Section 26, Township 61 North, Range 12 West; thence S 76 degrees 38 minutes 05 seconds E bearing based on Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve, thence SE'ly along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft to a point; thence S 02 degrees 31 minutes 39 seconds W, a distance of 694.58 ft to the N line of said SW1/4 of SW1/4 and also being the point of beginning of the line to be described; thence continuing S 02 degrees 31 minutes 39 seconds W, a distance of 256.53 ft; thence SW'ly, along a tangential curve concave to the NW having a radius of 1134.00 ft, central angle of 30 degrees 15 minutes 34 seconds, a distance of 598.90 ft to the point of reverse curve; thence SW'ly, S'ly and SE'ly, along said reverse curve concave to the E having a radius of 333.00 ft, central angle of 60 degrees 16 minutes 05 seconds, a distance of 350.27 ft to a point being 300.00 ft NW'ly of, measured at right angles to and parallel with ""Line B"" to be described and said ""Line A"" there terminating. ""Line B"" Commencing at the SW corner of said Section 25; thence S 88 degrees 33 minutes 39 seconds E along the S line of said Section 25, a distance of 334.90 ft to the beginning of the line to be described; thence N 14 degrees 59 minutes 50 seconds E, a distance of 70.97 ft; thence N 26 degrees 29 minutes 50 seconds E, a distance of 1393.23 ft to the N line of said SW1/4 of SW1/4 and said ""Line B"" there terminating. The side line of said 300.00 ft wide strip terminates on said ""Line A"" and the S line of said SW1/4 of SW1/4. "	FRANCONIA MINERALS (US) LLC	USA		6.911
610-0011-03650	25	61	12	SE1/4 OF SW 1/4	RENDFIELD LAND CO INC	STATE OF MINNESOTA		0.971
610-0011-03740	26	61	12	NE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		16.208
610-0011-03760	26	61	12	SW 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		20.88
610-0011-03770	26	61	12	SE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		25.9

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03780	26	61	12	"That part of the NE1/4 of the SE1/4 lying S'ly and SW'ly of the following described line: Beginning at the NW corner of the SE1/4 of NW1/4, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on St Louis County Transverse Mercardor 1996 Projection, a distance of 268.32 ft; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E, a distance of 486.88 ft; thence SE'ly along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E, a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly along said compound curve concave to the NW having a radius of 1433.00 ft; central angle of 22 degrees 33 minutes 42 seconds, a distance 564.28 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance 848.88 ft to the point of compound curvature; thence SE'ly along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 66 degrees 19 minutes 22 seconds, a distance 385.46 ft to the E line of said NE1/4 of SE1/4 and said line there terminating."	FRANCONIA MINERALS (US) LLC	DU NORD LAND CO (1/2)	"Emilie WashburnWorthen Hall (1/32) John Stuart Paine (1/32) Thomas H. Paine (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) Frederic Paine Worthen (1/22) Anna Welles Paines Williams (1/22) Rebecca Paine Field (1/22) Mary Paine Worthen (1/22) Mary Worthen Morton (1/22) State of Minnesota (391/2112)"	29.118

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03781	26	61	12	That part of the NE¼ of SE¼, Section 26, in Township 61 North, Range 12 West lying N'ly, NE'ly and NW'ly of the following described line: Beginning at the NW corner of SE¼ of NW¼, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on the Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft.; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft., central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft. to the point of tangency ; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft.; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft., central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft., central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft. to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft.; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft., central angle of 43 degrees 11 minutes 47 seconds , a distance of 251 . 05 ft. to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433. 00 ft., central angle of 22 degrees 33 minutes 42 seconds , a distance of 564.28 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft., central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft., central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft., central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft., central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 feet, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft.; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft.; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft., central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft. to the point of tangency; thence N 48 degrees 37 minutes 29 seconds E a distance of 90.93 ft.; thence N 00 degrees 00 minutes 00 seconds W a distance of 66.00 ft., thence N 28 degrees 00 minutes 12 seconds E a distance of 568.9 ft. to the N line of said NW¼ of SW¼, Section 25, and there terminating.	RENDFIELD LAND CO INC	DU NORD LAND CO (1/2)	"Emilie WashburnWorthen Hall (1/32) John Stuart Paine (1/32) Thomas H. Paine (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) Frederic Paine Worthen (1/22) Anna Welles Paines Williams (1/22) Rebecca Paine Field (1/22) Mary Paine Worthen (1/22) Mary Worthen Morton (1/22) State of Minnesota (391/2112)"	0.634
610-0011-03790	26	61	12	NW 1/4 OF SE 1/4	FRANCONIA MINERALS (US) LLC	ALLETE INC		30.063

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-03800 and 610-0011-03801	26	61	12	That part of the SW¼ of SE¼ Section 26 Township 61 North Range 12 West lying westerly, northwesterly and northerly of the following described line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence South 71 degrees 44 minutes 20 seconds West, bearing based on the east line of said Section 9 having a bearing of South 03 degrees 27 minutes 19 seconds East, St Louis County Transverse Mercator 1996 projection a distance of 462.67 feet; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears North 22 degrees 35 minutes 37 seconds West a distance of 2378.47 feet to the point of tangency; thence North 23 degrees 59 minutes 36 seconds East a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds a distance of 280.81 feet to the point of tangency; thence North 37 degrees 12 minutes 41 seconds East a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds a distance of 2168.30 feet to the point of tangency; thence North 04 degrees 21 minutes 02 seconds East a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds a distance of 2463.58 feet to the point of tangency; thence North 53 degrees 35 minutes 54 seconds East a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds a distance of 63.66 feet to the point of tangency; thence North 57 degrees 36 minutes 21 seconds East a distance of 1469.17 feet; thence North 32 degrees 23 minutes 39 seconds West a distance of 200 feet; thence North 06 degrees 23 minutes 50 seconds West a distance of 482.88 feet; thence North 34 degrees 17 minutes 24 seconds East a distance of 1692.54 feet; thence South 77 degrees 26 minutes 00 seconds East a distance of 1541.34 feet; thence North 52 degrees 08 minutes 41 seconds East a distance of 670.95 feet to the point of beginning of the line to be described; thence continuing North 52 degrees 08 minutes 41 seconds East a distance of 783.84 feet; thence North 68 degrees 02 minutes 16 seconds East a distance of 148.61 feet; thence North 50 degrees 50 minutes 08 seconds East a distance of 328.73 feet; thence North 41 degrees 52 minutes 40 seconds East a distance of 385.23 feet to the east line of said SW¼-SE¼ , and there terminating.	CLIFFS ERIE LLC AND TWIN METALS MN LLC.	PETER WOODBURY (3/4)	"DUNKA MINERALS CORP. (1/12) KMK DUNKA INC. (1/12) DRM MINERALS CORP. (1/12)"	0.677
610-0011-03810 and 610-0011-03811	26	61	12	UND 3/4 (CE) AND UND 1/4 (CE) OF SE1/4 OF SE1/4	CLIFFS ERIE LLC	PETER WOODBURY (3/4)	"DUNKA MINERALS CORP. (1/12) KMK DUNKA INC. (1/12) DRM MINERALS CORP. (1/12)"	0.048
610-0011-03860	27	61	12	SE1/4 OF SE1/4	USA	STATE OF MINNESOTA		0.333
610-0011-04400	33	61	12	SE1/4 OF SE 1/4	MESABI IRON CO	MESABI IRON CO		2.152

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04440	34	61	12	"That part of the NE1/4 OF NE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		22.694

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04441	34	61	12	That part of the NE¼ of NE¼, Section 34, Township 61 North, Range 12 West, EXCEPT that part lying W'ly and NW'ly of a line drawn parallel with and distant 200 ft. W'ly and NW'ly of the first following described line and W'ly, NW'ly and N'ly of the second following described line: First Described Line: Commencing at the E quarter corner of Section 9, Township 60 North, Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the E line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St Louis County Transverse Mercator 1996 projection, a distance of 462.67 ft. to the point of beginning of the line to be described; thence NE'ly along a non-tangential curve concave to the E, having a radius of 2925.20 ft., central angle of 46 degrees 35 minutes 13 seconds, the tangent to said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 ft. to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 ft.; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 ft., central angle of 13 degrees 13 minutes 05 seconds, a distance 280.81 ft. to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 ft.; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 ft., central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 ft. to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 ft.; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 ft., central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 ft. to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 ft.; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 ft., central angle of 04 degrees 00 minutes 27 seconds , a distance of 63.66 ft. to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 ft. and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 ft. to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of482.88 ft.; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 ft.; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 ft.; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 ft.; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 ft.; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 ft.; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 ft., and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		0.465
610-0011-04450	34	61	12	NW1/4 OF NE1/4	USA	STATE OF MINNESOTA		0.125
610-0011-04450	34	61	12	NW1/4 OF SW1/4	USA	USA		1.248
610-0011-04450	34	61	12	SE1/4 OF NW1/4	USA	USA		0.606
610-0011-04450	34	61	12	SW1/4 OF SW1/4	USA	USA		34.392

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04460	34	61	12	"That part of the SW1/4 OF NE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	USA		24.741

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04470	34	61	12	That part of the SE¼ of NE¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	USA		1.156

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04475	34	61	12	"That part of the SE1/4 OF NE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	USA		18.534

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04520	34	61	12	That part of the NE¼ of SW¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		0.886

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04525	34	61	12	"That part of the NE1/4 OF SW1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		26.34

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04550	34	61	12	That part of the SE¼ of SW¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		0.286

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04555	34	61	12	"That part of the SE1/4 OF SW1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		15.915

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04570	34	61	12	That part of the NW¼ of SE¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		3.004

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04575	34	61	12	"That part of the NW1/4 OF SE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		13.173

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04645	35	61	12	Northeast Quarter of Northwest Quarter, Section 35, Township 61 North, Range 12 West, St. Louis County, Minnesota, lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast , having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds , a distance of 2463.58 feet to the point of tangency ; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet ; thence northeasterly along a tangential curve concave to the southeast , having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	State of Minnesota (Remainder. See notes)	"Dunka Minerals Corporation (20/864) KMK Dunka Inc. (20/864) DRM Minerals Corporation (20/864) Harold A. Knutson, as trustee of the Harold A. Knutson Living Trust under Agreement dated April 30, 2008 (5/576) Darryl E. Coons (5/576) Duluth-Superior Area Community Foundation (5/576) Peter Woodbury (180/864) Nancy Jordan (1/10 of 10/864) Susan Eastep (1/10 of 10/864) Cynthia Williams (1/10 of 10/864) John Mahler (1/10 of 10/864) Elizabeth Gowdy (1/10 of 10/864) The Thomas J. Manthey Disclaimer Trust F/B/O Virginia P Manthey (1/2 of 864) John Jacob Spencer Jr. (10/4032) Frank Christopher Spencer (10/4032) Charlotte Spencer Miller (10/4032) Florence Spencer Schmidt (10/4032) Helen Spencer Morley (10/4032) Rexford A. Emery (10/4032) Jane M. Spencer and Norman Miller Spencer Jr. (5/4032) Norman Miller Spencer Jr. (5/4032) Jean Thomas Johnson, as Trustee of the Second Amended and Restated Jean Thomas Johnson Family Trust (U/D/T/D/10-8-1992), executed February 15, 2010 (5/576) Margaret T. Fleischmann (15/864) State of Minnesota (remainder)"	0.314

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04650	35	61	12	That part of the NW¼ of NW¼, Section 35 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		5.956

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04655	35	61	12	"That part of the NW1/4 OF NW1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating."	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		13.584
610-0011-04760	36	61	12	SE1/4 OF SE1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		1.985
610-0011-04760	36	61	12	SW1/4 OF SE1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		7.441
610-0011-04800	36	61	12	NE1/4 OF NW1/4 TO THE WEST OF THE NORMAL HIGH WATER MARK OF BIRCH LAKE	RENDFIELD LAND CO INC	STATE OF MINNESOTA		0.772

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04810	36	61	12	"NW1/4 of Section 36 Township 61 North Range 12 West of the Fourth Principal Meridian EXCEPT SE1/4 of NW1/4, Section 36, Township 61 North, Range 12 West. AND FURTHER EXCEPT Those parts of NW1/4 of NW1/4, Section 36, Township 61 North, Range 12 West, lying W'ly of ""Line A"" to be described and 300.00 feet NW'ly of and 300.00 SE'ly of, measured at right angles to and parallel with ""Line B"" to be described. ""Line A"" and ""Line B"" are described as follows; ""Line A"" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said NW1/4 of NW1/4, a distance of 334.90 feet; thence E'ly a distance of 22.42 feet along a non-tangential curve concave to the N, having a radius of 333.00 feet, a central angle of 03 degrees 51 minutes 28 seconds, and a chord bearing S 89 degrees 30 minutes 36 seconds E; thence E'ly a distance of 257.22 feet along a reverse curve concave to the S, having a radius of 484.00 feet, and a central angle of 30 degrees 26 minutes 59 seconds to the beginning of the line to be described; thence continuing E'ly a distance of 491.25 feet along the same curve having a radius of 484.00 feet, a central angle of 58 degrees 09 minutes 15 seconds; thence S 03 degrees 48 minutes 53 seconds E, a distance of 919.86 feet to the S line of said NW1/4 of NW1/4 and said ""Line A"" there terminating. ""Line B"" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1325.94 feet and said ""Line B"" there terminating. The side lines of said 300.00 foot wide strips terminate on the N and W lines of said NW1/4 of NW1/4. AND FURTHER EXCEPTING That part of SW1/4 of NW1/4 Section 36, Township 61 North, Range 12 West, lying 300.00 SE'ly of, measured at right angles to and parallel with a line described as follows: Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1895.30 and said line there terminating. The said line of said 300.00 foot wide strip terminates on the N and W lines of said SW1/4 of NW1/4. "	RENDFIELD LAND CO INC	STATE OF MINNESOTA		19.391
610-0011-04811	36	61	12	"Those parts of NW1/4 of NW1/4, Section 36, Township 61 North, Range 12 West, lying W'ly of ""Line A"" to be described and 300.00 feet NW'ly of and 300.00 SE'ly of, measured at right angles to and parallel with ""Line B"" to be described. ""Line A"" and ""Line B"" are described as follows; ""Line A"" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said NW1/4 of NW1/4, a distance of 334.90 feet; thence E'ly a distance of 22.42 feet along a non-tangential curve concave to the N, having a radius of 333.00 feet, a central angle of 03 degrees 51 minutes 28 seconds, and a chord bearing S 89 degrees 30 minutes 36 seconds E; thence E'ly a distance of 257.22 feet along a reverse curve concave to the S, having a radius of 484.00 feet, and a central angle of 30 degrees 26 minutes 59 seconds to the beginning of the line to be described; thence continuing E'ly a distance of 491.25 feet along the same curve having a radius of 484.00 feet, a central angle of 58 degrees 09 minutes 15 seconds; thence S 03 degrees 48 minutes 53 seconds E, a distance of 919.86 feet to the S line of said NW1/4 of NW1/4 and said ""Line A"" there terminating. ""Line B"" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1325.94 feet and said ""Line B"" there terminating. The side lines of said 300.00 foot wide strips terminate on the N and W lines of said NW1/4 of NW1/4. "	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		10.944
610-0011-04821	36	61	12	That part of SW1/4 of NW1/4 Section 36, Township 61 North, Range 12 West, lying 300.00 SE'ly of, measured at right angles to and parallel with a line described as follows: Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1895.30 and said line there terminating. The said line of said 300.00 foot wide strip terminates on the N and W lines of said SW1/4 of NW1/4.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		31.131
610-0011-04840	36	61	12	NE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		15.511
610-0011-04850	36	61	12	NW 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		28.883

Parcel ID	Section	Township	Range	Legal Description	Surface Owner	Majority Mineral Ownership	Minor Mineral Ownership	Acres
610-0011-04860	36	61	12	SW 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		0.787
610-0011-04870	36	61	12	SE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		31.431

Abbreviations:
% = percent
DESC = described
E = east
EX = exempt
EXCL = excluding
FT = feet
GOVT = government
MN = Minnesota
N = north
NE = northeast
NO = number
NW = northwest
S = south
SE = southeast
SLY = southerly
SW = southwest
UDI = undivided interest
USA = United States of America
W = west
W = westerly