# MINE PLAN OF OPERATIONS

## TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

**Twin Metals Minnesota LLC**

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## REVISION RECORD

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## REVISION NARRATIVE

Not Applicable

## DISCLAIMER

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**Twin Metals Minnesota Project: An Introduction**

Twin Metals Minnesota (TMM) is proud to formally propose its world-class, 21st century underground copper, nickel, cobalt and platinum group metals mining project in northeast Minnesota for environmental review.

The submission of TMM's Mine Plan of Operations (MPO) to the U.S. Bureau of Land Management (BLM), and the Scoping Environmental Assessment Worksheet (SEAW) data submittal to the Minnesota Department of Natural Resources (MDNR), is the culmination of a decade of engineering, environmental and engagement work including the evaluation of dozens of Project configurations and technologies that maximize environmental protection. If permitted, TMM's Project will be the state's first underground mining operation – an approach that minimizes surface disruption, noise and dust -- since the closure of Ely's Pioneer Mine in 1967.

For more than 135 years, Minnesota has been a leader in both mining development and regulation to ensure strong environmental and labor standards. TMM is dedicated to building, operating, and closing a mine that employs industry best practices and meets or exceeds all state and federal environmental standards.

Submission of the MPO and SEAW starts a multi-year environmental review process that will thoroughly evaluate this proposal. The review process will include additional baseline data collection, impact analysis, and multiple opportunities for public input. TMM looks forward to this process and the engagement with government and the public which will result in the best outcomes for Minnesota.

The TMM Project site is located between the cities of Ely and Babbitt, an area long-sustained by mining and other industries, including farming, logging, quarries, and recreation. The area in and around Ely alone was once home to 11 operating mines. The site is in an area of the Superior National Forest designated for mining and logging within the U.S. Forest Service Superior National Forest Plan. The Project is outside of the Boundary Waters Canoe Area Wilderness and both the federal and state mining exclusion zones meant to provide a buffer from development.

The TMM Project offers an extraordinary opportunity for long-term, environmentally sound economic growth and job creation in a region of northeastern Minnesota that never fully recovered from iron mine and processing plant closures a generation ago. The construction phase of the project will require several million labor hours under a project labor agreement already negotiated with the Iron Range Building and Construction Trades Council. Once the mine is operational, it will bring 700 new full-time, skilled positions and 1,400 spinoff jobs to the region. Investment in the Project to date is over $450 million and is expected to amount to approximately $1.7 billion through construction of the mine. The Project would provide additional economic benefit by generating revenue for state and federal governments from taxes and mineral royalties.

The growing demand for copper, nickel, cobalt and platinum group metals in technologies from cell phones to clean energy production has made these minerals critical to advancing the quality of life of populations around the globe. The Duluth Mineral Complex beneath this part of northeastern Minnesota is one of the largest
undeveloped deposits of these minerals in the world, with more than 7 billion tons of ore containing copper, nickel and other precious metals. Failure to access the minerals of the Duluth Complex will create pressures to mine these metals in other locations that have much less rigorous environmental and labor standards.

TMM and its predecessor company engaged in mineral resource characterization of the Maturi deposit, in the northern area of the Duluth Complex, from 2006 to 2014. This effort has produced detailed characterization of mineral resources. To date, TMM's core storage facility houses approximately 1.5 million feet of core samples from the Maturi deposit; about a half million additional feet of core samples have been sent to state storage facilities. Following mineral resource characterization, several years of process flowsheet engineering work led to conceptual and initial prefeasibility studies.

The outcome of these studies minimized potential impacts in the areas of water, wetlands, noise, dust, light and visual pollution. Specific examples include:

- Project optimization reduced the surface footprint by over four times;
- Ore processing would remove most of the sulfide minerals; therefore, tailings would not produce acid rock drainage (ARD);
- Up to 50% of tailings would be diverted from surface storage and instead be utilized as backfill in the underground mine;
- Tailings stored on surface would be dewatered and compressed which is called dry stacking;
- Adopting dry stacking as the tailings management method reduced the surface impact by approximately 35% and wetlands impact by approximately 65% compared to a previous conventional slurry tailings storage configuration;
- The dry stack facility would not have dams retaining tailings slurry, would be lined and covered, would eliminate a long pipeline to transport tailings to another location, and would be revegetated concurrently as the Project progresses reducing visual impacts;
- The Project would not discharge process water and is designed not to require discharge of contact water. Water used in the mineral concentration process would be reused on site;
- No waste rock would be stored on the surface, eliminating a potential source of ARD;
- Ore crushing would be underground, limiting surface impact, dust and noise;

- No mining would occur under Birch Lake reservoir; and
- After mine closure, most of mine infrastructure would be removed and the surface area revegetated.

**Project at a glance:**

- Construction of the mine would occur over two to three years;
- The mine would process 20,000 tons of ore per day;
- Mining operations would occur between 400 and 4,500 feet below the surface;
- The tailings management site would be approximately one mile south of the underground mine and encompass the dry stack tailings facility;
- The plant site includes access to the underground mine and the concentrator used to recover target minerals from ore;
- The mine would be accessed via declines at the plant site with workers and supplies transported by truck;
- Flow of groundwater in bedrock is exceptionally low;
- Water for operations would be reused on site and be sourced from stormwater, groundwater inflow into the mine, and from Birch Lake reservoir;
- Power would be supplied via a transmission corridor from an off-site electrical substation;
- Site employees would be bused to site from Ely and Babbitt, minimizing traffic;
- The Project would operate under National Mining Association CORESafety Program standards, a systematic approach to developing a safety culture.

As the World Bank noted earlier this year in its Climate Change report, the world is rapidly transitioning to low-carbon technologies to combat climate change and will require large quantities of minerals to succeed. The report notes that a single three-megawatt wind turbine requires 4.7 tons of copper. Lithium-ion batteries used in everything from electric vehicles to power grids rely heavily on cobalt, one of the key minerals identified in the Maturi deposit. Catalytic converters, which reduce carbon monoxide emissions from internal combustion engines, use another: platinum group metals such as palladium. Nickel is a key component of corrosion-resistant alloys such as stainless steel and copper-nickel tubing in desalinization plants. The report projects that the transition to green energy will require as much copper in the next 25 years as has been produced in the past 5,000 years.

This Project offers the opportunity to provide the minerals essential to the green economy responsibly, with the rigorous environmental and labor standards that are uniquely present here in America – specifically in Minnesota. TMM's commitment is to operate sustainably and preserve and protect our precious natural world as we support the new, green economy.

Closer to home, hundreds of union jobs, over a thousand spinoff jobs, as well as tax payments and royalties will improve the quality of life in Minnesota and specifically in communities that are struggling economically. TMM's Project raises the bar for how to best extract necessary minerals for society. With this Project, Minnesota can be a model for modern, sustainable and environmentally and socially responsible mining.

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## LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

| | |
|---|---|
| < | less than |
| > | greater than |
| ° | degree |
| % | percent |
| § | section |

| | |
|---|---|
| AADT | annual average daily traffic |
| amsl | above mean sea level |
| AO | Authorized Officer |
| ARD | acid rock drainage |
| ARDC | Arrowhead Regional Development Commission |
| bgs | below ground surface |
| BLM | Bureau of Land Management |
| BMP | Best Management Practice |
| BMZ | basal mineralized zone |
| BWCAW | Boundary Waters Canoe Area Wilderness |
| C | Celcius |
| CAA | Clean air Act |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| cm | centimeter |
| cm/sec | centimeters per second |
| CO | carbon monoxide |
| CWA | Clean Water Act |
| dBA | decibels as measured on the A-weighted scale |
| DOT | Department of Transportation |
| EDMS | Environmental Data Management System |
| e.g. | Latin phrase exempli gratia meaning “for example” |
| EJ | Environmental Justice |
| ELT | Ecological Land Type |
| F | Fahrenheit |
| ft | foot |
| gal | gallon |
| gal/hr | gallon per hour |
| GAP | Gap Analysis Program |
| gpm | gallons per minute |
| GRB | Giants Range Batholith |
| H:V | horizontal to vertical |
| ha | hectare |
| HDPE | high density polyethylene |
| HHS | U.S. Department of Health & Human Services |
| HU | Hydrogeologic Unit |
| HUC | Hydrologic Unit Code |
| HWY | highway |
| IBI | Biotic Integrity |

| | |
|---|---|
| i.e. | Latin phrase *id est* meaning "That is (to say)…" |
| INCO | International Nickel Company, Ltd |
| km | kilometers |
| L | liter |
| LHD | load-haul-dump |
| LLDPE | linear low-density polyethylene |
| LLR | longitudinal longhole retreat |
| LMF | Laurentian Mixed Forest |
| LOS | level of service |
| m | meter |
| $m^3$ | cubic meter |
| $m^3$/hr | cubic meter per hour |
| MBTA | Migratory Bird Treaty Act |
| MDA | Minnesota Department of Agriculture |
| MDNR | Minnesota Department of Natural Resources |
| meq/L | Milliequivalent per liter |
| MnDOT | Minnesota Department of Transportation |
| mm | millimeter |
| MPCA | Minnesota Pollution Control Agency |
| MPO | Mine Plan of Operations |
| Mst | Million short tons |
| MSHA | Mine Safety and Health Administration |
| Mt | Million tonnes |
| 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 Wetland Inventory |
| OHV | off-highway vehicle |
| OSA | Office of the State Archaeologist |
| OSHA | Occupational Safety and Health Administration |
| PR | potential cultural resources |
| Project | Twin Metals Minnesota Project |

| | |
|---|---|
| Q | quarter |
| QUM | Quaternary Unconsolidated Materials |
| RCRA | Resource Conservation and Recovery Act |
| RFSS | Regional Forester Sensitive Species |
| ROS | Recreational Opportunity Spectrum |
| SAG | semi-autogenous grind |
| SARA | Superfund Amendments and Reauthorization Act |
| SEH | Short Elliott Hendrickson, Inc. |
| SGCN | Species in Greatest Conservation Need |
| SHPO | State Historic Preservation Officer |
| SKA | South Kawishi Association |
| SKI | South Kawishiwi Intrusion |
| SNF | Superior National Forest |
| $SO_2$ | sulfur dioxide |
| st | short ton |
| SWPPP | Stormwater Pollution Prevention Plan |
| TDS | total dissolved solids |
| TH | Trunk Highway |
| TMM | Twin Metals Minnesota LLC |
| U.S. | United States |
| µg/L | micrograms per liter |
| µS/cm | microSiemens per centimeter |
| USFS | U.S. Forest Service |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| $yd^3$ | cubic yard |

## 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 when it originates from mining areas.

**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 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.

**Clean Air Act (CAA):** 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.

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

**Comprehensive Environmental Response, Compensation, and Liability Act:** Commonly known as Superfund, this act was enacted by Congress on December 11, 1980 and created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. This law established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified. The law authorizes two kinds of response actions**:**

- short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response; and
- long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on the U.S. Environmental Protection Agency's National Priorities List.

**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, includes grinding, gravity flotation, concentrate dewatering, concentrate storage and loadout, and reagent makeup. The concentrator is 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 stormwater:** Direct precipitation or stormwater that has contacted surfaces disturbed during construction

**contact water:** Water, in the form of precipitation or stormwater runoff, that would potentially come in contact with ore or, tailings, or waste rock, but has not been used in the process or combined with process water.

**contact water ditches:** A ditch around the dry stack facility that collects runoff of the dry stack facility and directs it to the tailings management site contact water ponds. Additionally, the over-liner drain and under-liner drain are both directed to this ditch for conveyance to the contact water pond.

**contact water ponds:** Contact water ponds are built to manage contact water for the tailings management site and are named 1 through 5 from west to east.

**contaminant:** A substance that pollutes air, soil, or water. It may also be a hazardous substance that does not occur naturally or that occurs at levels greater than those found occurring naturally in the environment.

**contaminate:** To make (something) dangerous, dirty, or impure by adding something harmful or undesirable to it.

**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.

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

**dam:** A structure that impounds water.

**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.

**development rock:** Sulfide barren rock mined from the hanging wall that would be used for construction aggregate. Development rock would be mined during the construction of the declines and ventilation raises, and periodically throughout the Project.

**dike:** A structure that directs the flow of water.

**draindown:** Water that would be collected in the dry stack facility over-liner drain.

**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. Since the tailings would be filtered and the majority of water is removed, a dry stack facility does not require a dam or berm. 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.

**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.

**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.

**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.

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

**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 produces 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.

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

**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:** An outcrop of the Giants Range Batholith that forms a narrow surface ridge that strikes east-northeast.

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

**gravity circuit:** Process circuit within the comminution circuit used to recover dense minerals and produce the gravity concentrate.

**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 a 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 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 Code of Federal Regulations 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).

**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.

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

**laydown area:** Area used for material and equipment storage during the construction phase of a project.

**mine dewatering:** Water that is pumped out of the mine from the underground sumps. Various water source can report to the sumps and they are mine inflow, engineered tailings backfill bleed water, engineered tailings backfill line flush water, dust suppression, and equipment water.

**mine inflow:** Groundwater that flows into the mine.

**mine services building:** The building that contains the truck shop, mine dry, and warehouse.

**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 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 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.

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

**noise sensitive area:** An area that, because of its use by humans or special status wildlife species and the importance of reduced noise levels to such use, is designated for management which limits the noise level from long-term and/or continuous noise producing sources.

**non-contact stormwater:** Stormwater that has not been affected by sulfides and metal leachates from oxidized rock exposed through mining.

**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 which 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 tailings management site.

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

**ore:** Rock that contains the targeted metals which would be processed by TMM through the concentrator to recover targeted metals into three concentrates; ore is found in the basal mineralized zone of the Maturi deposit.

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

**overflow ore stockpile:** The overflow ore stockpile would be located on the temporary rock storage facility and would serve to feed the concentrator during shutdowns of the underground mine and would exist intermittently during operations.

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

**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.

**plant site:** The portion of the Project area that would encompass the following Project features: north contact water pond, central contact water pond, south contact water pond, process water pond, concentrator, temporary rock storage facility, pre-operational ore stockpile, overflow 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.

**platinum group metals:** Platinum group metals are six chemical similar elements cluster together in the periodic table. The six elements are iridium, osmium, palladium, platinum, rhodium, and ruthenium. This definition has been expanded by the Project to also include gold and silver.

**$PM_{2.5}$**: 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.

**pre-operational ore stockpile:** During construction of the mine, before the concentrator is commissioned, ore would be temporarily stockpiled on the temporary rock storage facility. This stockpile on the temporary rock storage facility is the pre-operational ore stockpile.

**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 that, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

**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 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. Actions intended to return the land surface to an equivalent undisturbed condition. Restoration of mined land to original contour, use, or condition. Steps or operations integral to mining that prepare the land for post-mining use are called reclamation. When the objective of reclamation is to return the land to pre-mining conditions and uses, it is sometimes called restoration.

**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.

**slurry:** A watery mixture or suspension of fine solids (not thick enough to be considered sludge).

**sediment pond:** A pond used for settling suspended solids.

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

**standards:** Samples containing a known amount of contaminant.

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

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

**tailings:** Waste byproducts of mineral beneficiating processes other than heap and dump leaching, consisting of rock particles, which have usually undergone crushing and grinding, from which the profitable mineralization has been separated.

**tailings dewatering plant:** Includes the process facilities associated with the tailings thickener, filter plant, filter cake storage & storage loadout building, and backfill plant.

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

**tailings management site:** The dry stack facility and other Project facilities in same geographic area.

**tailings thickener:** The equipment used to initially dewater tailings before being fed to the filter plant.

**temporary rock storage facility**: A lined facility at the plant site that would convey precipitation to the central contact water pond. The temporary rock storage facility is the physical infrastructure on which the pre-operational ore stockpile and the overflow ore stockpile would be located.

**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.

**under-line drain:** A drain underneath the dry stack facility liner that would drain to the contact water ditch.

**underground mine:** This would include 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.

**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 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.

**United States Forest Service Regional Foresters 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.

**ventilation access road:** An existing drill road would be upgraded in order to accessed ventilation raise site 1 and 2. Ventilation raise site 3 would be accessed via the existing forest service 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, ventilation raise site 2, ventilation raise site 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 mined during operations below the targeted cut-off grade that would be managed underground and placed in mined out stopes for permanent storage.

**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.

**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 OPERATOR INFORMATION

The names, addresses, and telephone numbers of those responsible for Project operations to whom notices and orders are to be delivered are identified in Section 1.1 and Section 1.2. Twin Metals Minnesota LLC (TMM) would notify the U.S. Department of the Interior Bureau of Land Management (BLM) Northeast States Office and the United States Forest Service (USFS) Superior National Forest (SNF) in writing within 30 calendar days of any change of operator or corporate point of contact or of any change in the mailing address of the operator or corporate point of contact.

## 1.1 Operator Information

| | |
|---|---|
| Operator Name: | Twin Metals Minnesota LLC |
| Mailing Address: | 380 St. Peter Street, Suite 705<br>St. Paul, Minnesota 55102 |
| Telephone Number: | +1 651-842-6800 |
| Fax Number: | +1 651-842-6801 |
| Tax Payer ID: | 42-1772768 |
| Point of Contact: | Derek Heinecke |
| Emergency Contact: | Environmental Manager |

## 1.2 Company Information

### 1.2.1 Chief Executive Officer

| | |
|---|---|
| Full Name: | Kelly Osborne |
| Street Address: | 380 St. Peter Street, Suite 705<br>St. Paul, Minnesota 55102 |
| Telephone Number: | +1 651-842-6800 |
| Fax Number: | +1 651-842-6801 |

### 1.2.2 Chief Regulatory Officer

| | |
|---|---|
| Full Name: | Julie Padilla |

| | |
|---|---|
| Street Address: | 380 St. Peter Street, Suite 705<br>St. Paul, Minnesota 55102 |
| Telephone Number: | +1 651-842-6800 |
| Fax Number: | +1 651-842-6801 |

### 1.3 Organizational Structure

TMM's organizational structure is illustrated in Figure 1-1.

## 2.0 DESCRIPTION OF OPERATIONS

The 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 the city of Ely, Minnesota, and 11 miles (18 km) northeast of the city of Babbitt, Minnesota, 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. The Project location and general Project layout, consisting 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, are identified on Figure 2-1 and Figure 2-2, respectively. The surface disturbance of each of these Project features are summarized in Table 2-1. A simplified Project schematic is illustrated on Figure 2-3. Mineral tenure information is included in Appendix A.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations.

The purpose of this Mine Plan of Operations (MPO) document is to provide necessary information for the environmental review and permitting process. Specifically, this MPO addresses requirements for leasable minerals as per 43 Code of Federal Regulations (CFR) section (§) 3592 (Table 2-2). All references to federal and state statutes and regulations reference those in effect as of the date of filing.

The Project would develop an underground mine at the Maturi deposit. In the underground mine, the ore would be blasted using explosives. The blasted ore would be transported by load-haul-dump machines and haul trucks to underground crushers. The underground crushers would crush the ore to a smaller size for transportation out of the underground workings by conveyor.

The crushed ore would be fed to the concentrator to recover the targeted metals (copper, nickel, cobalt, platinum, palladium, gold, and silver) as concentrates. The first step in processing would be to further reduce the particle size of the ore through grinding. The ground ore would be fed to the flotation circuit where sequential flotation would produce a copper concentrate and a nickel concentrate. A gravity concentration circuit would be installed to recover the higher density platinum, palladium, and gold minerals to a gravity concentrate. The three saleable products (copper concentrate, nickel concentrate, and gravity concentrate) would be dewatered through the use of thickeners and filters. The copper and nickel concentrates would be loaded into enclosed containers that would be transported by semi-trucks via public roads to a transload facility where the concentrate could be loaded to rail or boat for further transport.

During the flotation process, tailings would be produced as a waste byproduct. Tailings would no longer have economically recoverable copper, nickel, cobalt, platinum, palladium, gold, and silver as it would have been removed during processing. The Project would permanently store the tailings in two forms: as an engineered tailings backfill product used to fill the voids created by mining; and placed as a tailings filter cake to form a dry stack facility.

## 2.1 Background and History

Among copper, nickel, and platinum group metal deposits, the Duluth Complex ranks second in the world for contained copper and third in the world for contained nickel.

Grant (1899) and Nebel (1919) were the first to have noted the occurrence of copper sulfides in outcrops of the Duluth Complex. The first significant find of base metal mineralization in northern Minnesota was in 1948 by a local Ely prospector, F.S. Childers, in a road cut near the South Kawishiwi River on what is now the Spruce Road (Miller et al., 2002). Relatively contemporaneously, a similar copper-nickel mineralization was found in another road cut when driving down the Dunka Road about 10 miles (16 km) to the southwest. These two discoveries attracted the attention of at least 22 mineral exploration companies which began to drill the basal aspects of the Duluth Complex in 1952. Drilling has continued sporadically though to present day. From 1948 through 2000, more than 2,800 drill holes, totaling over 1.4 million feet (ft) (760,000 meters [m]) of core, were drilled in the Duluth Complex.

In 1953, the United States (U.S.) Bureau of Mines drilled three holes at Spruce Road. The Spruce Road deposit, the western and shallow northeast portions of the Maturi deposit, and Maturi Southwest were leased shortly thereafter by the International Nickel Company, Ltd (INCO). INCO drilled a total of 60 holes in the Maturi area from 1954 to 1970, totaling 57,614.4 ft (17,560 m) of drilling. From 1968 to1969, INCO sunk a shaft in the Maturi deposit to a depth of 1,095 ft (334 m). A 1975 INCO study refers to a 635 tonne sample of shaft material being sent off-site as a bulk mineralogical sample. There have been no records found that define the grade of the sample, grade of the concentrate produced, nor any indication of who conducted the subsequent metallurgical studies.

During this same period, several other exploration companies had leases and conducted limited deeper drilling and other exploration activities in the Maturi area on adjacent leases. These companies include Duval, Newmont, and Hanna.

From the mid-1970s to 2005, two holes were drilled in Maturi by Wallbridge Mining as a twin hole to INCO hole 11526. In 2006, Duluth Metals began drilling on the leases previously held by Duval and Newmont, referring to it as the “Maturi Extension” and later renaming it Nokomis. Duluth Metals entered a joint venture with Antofagasta PLC in 2010, rebranding the Project as Twin Metals Minnesota.

In 2011 the deposits were renamed back to Maturi. In 2015, Anatofagasta PLC subsequently acquired 100 percent (%) ownership of Duluth Metals. Today Antofagasta PLC owns 100% of Franconia (US) LLC, Twin Metals Minnesota LLC, and Duluth Metals.

## 2.2 Site Access

The Project would be accessed by a permanent access road (access road) which would extend from Highway (HWY) 1 (also known as Trunk Highway 1 [TH 1]) to the northern edge of the plant site, as illustrated in Figure 2-2. The access road is discussed further in Section 2.7. A typical cross section of the access road is included Figure 2-4.

### 2.2.1 Underground Mine

The underground mine would be accessed from portals located within the plant site. The portals would lead to two declines (Figure 2-5). Access to ventilation raise sites would be from an existing USFS road (National Forest Road [NFR] 1900) and exploration drill roads.

Existing exploration drill roads would be extended or upgraded to a single-lane unpaved road to create the ventilation raise access road as illustrated on Figure 2-2. A typical single-lane road cross section is included as Figure 2-6.

### 2.2.2 Plant Site

The plant site would be accessed from TH 1 via the access road (Figure 2-2). A staffed gatehouse would be located on the northern edge of the plant site to provide controlled access to the Project from the access road (Figure 2-5).

### 2.2.3 Tailings Management Site

The tailings management site is located directly to the south of the plant site, accessed via internal site roads (Figure 2-2 and Figure 2-7).

### 2.2.4 Non-Contact Water Diversion Area

The non-contact water diversion area would be accessed directly from the plant site and tailings management site via internal site roads (Figure 2-5 and Figure 2-7).

### 2.2.5 Water Intake Corridor

Access to the water intake corridor would originate from the plant site as illustrated on Figure 2-5. A typical cross section of the water intake corridor and associated access road is included as Figure 2-8. The water intake corridor is discussed further in Section 2.8.

### 2.2.6 Transmission Corridor

The transmission corridor would originate from an off-site electrical substation and terminate at the plant site electrical substation as illustrated on Figure 2-2. The transmission corridor would be accessed from the plant site, an existing road to the off-site electrical substation, or intermittently along the corridor from existing USFS roads. A typical cross section of the transmission corridor is included as Figure 2-9. The transmission corridor is discussed in further detail in Section 2.9.

## 2.3 Underground Mine

To achieve efficient recovery of the resource, underground mining at the Project would utilize the longitudinal longhole retreat (LLR) mining method with backfill. For this mining method, primary and secondary stopes (excavations in the underground mine) would be separated by sill pillars and rib pillars. The use of sill and rib pillars, as well as the backfilling of mined stopes with waste rock and engineered tailings backfill would provide confinement to the pillars between the stopes and ensure long-term stability of the underground mine. Additionally, to prevent subsidence, the Project would operate with an appropriate crown pillar depth.

Approximately 40% to 60% of the mineral resource within the designed underground mine would be left in sill and rib pillars for geotechnical stability purposes. These resources would be rendered un-minable by the LLR mining method at the cessation of mining operations. The recovery rates identified are a result of the economic feasibility of using the LLR mining method. The use of the LLR mining method was chosen as it allows for the long-term stability necessary for safe operations and the appropriate crown pillar depth to prevent subsidence. Mine stopes are generally designed around a proposed cutoff grade of 0.4% copper. However, all mineralized materials removed from the underground mine would be processed. Processing (as discussed in Section 2.4.4 and Section 2.4.5) would remove 70% to 94% of the targeted metals, depending on the metal (copper, nickel, cobalt, platinum, palladium, gold, or silver).

### 2.3.1 Portals and Declines

Two parallel declines, the conveyor decline (to the west) and the access decline (to the east), would be excavated to provide access to the subsurface orebody and underground workings. Each decline would be approximately 20 ft wide by 20 ft in height (6 m by 6 m).

To limit the distance of overland conveying from the portals, the decline portals would be located close to the coarse ore stockpile the temporary rock storage facility (Figure 2-5). Portal and mine decline development are discussed in Section 2.16.8.

#### Conveyor Decline

The conveyor decline would be the western of the two declines (Figure 2-5). The length of the conveyor decline from the portal to the initial haulage level tie-in would be approximately 1.6 miles (2.5 km). The conveyor decline would house the decline conveyor which would transfer ore from the mine to the surface and would eventually extend further down the deposit as mine development progresses.

After the conveying system is installed, the conveyor decline would provide a main exhaust path for the mine ventilation system and would serve as secondary access to the underground mine.

#### Access Decline

The access decline would accommodate 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 emergency egress. This decline would provide a fresh air escape way, up-casting fresh air from the intake ventilation raises.

### 2.3.2 Blasting

A centralized blasting system would work in conjunction with the proposed digital leaky feeder system to provide full, two-way blast control for underground applications. This system would allow blasts to be initiated a safe distance from the blasting site.

Primary explosives products would include:

- Sensitized bulk emulsion;
- Electronic detonators; and
- Primers, boosters, and detonation cord.

Anticipated quantities of emulsion to be used for the Project are provided in Table 2-3.

### 2.3.3 Crushing and Underground Ore Handling System

Once drilled and blasted, load-haul-dump (LHD) equipment, either remotely or manually operated, would extract ore from the trough drift, through the drawpoint, and haul it to an orepass located in the extraction level.

The orepass would transfer ore from the extraction level to the haulage level where it would be rehandled by another LHD directly into a crusher or to a 40-ton truck that would haul the material to the closest crusher. Semi-portable jaw crushers would be located at crushing stations near the highest production orepasses. At the crushing stations, ore would be crushed to an approximate passing diameter of six inches (15 centimeters [cm]). The crushed material would then be conveyed to the decline conveyor via a transfer conveyor. The decline conveyor would transport ore to the coarse ore stockpile via the conveyor decline. A schematic of the underground workings is shown in Figure 2-10.

### 2.3.4 Backfill

Approximately 33 Million short tons (Mst) (30 Million tonnes [Mt]) of waste rock would remain underground as backfill and approximately 71 Mst (64 Mt) (40% of tailings) would be delivered underground for placement as engineered tailings backfill for a total of 104 Mst (94 Mt) of material backfilled into the mine (33 Mst + 71 Mst = 104 Mst or 30 Mt + 64 Mt = 94 Mt). Engineered tailings backfill production is described in Section 2.5.4.

#### Waste Rock Backfill

Waste rock from the underground development headings would be placed into stopes as backfill material and would generally be combined with engineered tailings backfill.

#### Engineered Tailings Backfill

**Backfill Distribution System**

Backfill distribution would be performed through one of the declines from the backfill plant located within the tailings management site (Section 2.5.4). From the main underground distribution point at the bottom of the conveyor decline, the engineered tailings backfill material would be distributed throughout the mine by pipes in the hanging wall. The underground distribution system would adapt to the mine plan as mining progresses through the various production areas.

Engineered tailings backfill material would be pumped into the stopes in two phases:

- Plug Pour - Phase I: A plug pour would be used to seal the drawpoint access in the stope. The drawpoint plug pour would be designed to fill the stope to one m above the drawpoint brow. The plug pour must cure for an appropriate amount of time before the second phase of backfilling can proceed.

- Fill Pour - Phase II: Once the scheduled cure of the plug pour has lapsed, a fill pour would commence. The fill pour phase would utilize engineered tailings backfill with enough binder to prevent liquefaction. Upon completion of the fill pour, it must cure for an appropriate amount of time before adjacent stopes can be mined. The binder would increase the structural integrity, minimize movement of water, and enhance the chemical stabilization of the engineered tailings backfill.

**Barricades**

Barricades would be used as a means of backfill containment during backfilling operations. Two elevations would be available for barricade construction per stope: one barricade at the drawpoint and one barricade at the drill drift.

### 2.3.5 Mine Dewatering System

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; and
- Mine supply water.

The mine inflow, a contributor to the mine dewatering rate, would change throughout the development of the underground workings.

Process water associated with the engineered tailings backfill would include engineered tailings backfill bleed water and engineered tailings backfill line flush water.

Mine supply water would be pumped underground from the process water pond and used for dust suppression and equipment requirements like drill water and satellite workshop wash bays. Excess mine supply water would be recaptured through a series of sumps.

Using collection sumps, face pumps, skid pumps, tank pumping stations, and secondary and primary pump stations, underground mine water would be pumped from the underground, de-oiled on the surface using oil-water separators and clarified in the sediment pond at the plant site. Excess water from the sediment pond not reused in the mine would report to the process water pond.

A portable slurry pump would be used to periodically sluice sediment from the sediment pond to the tailings thickener or other appropriate location for management and disposal.

### 2.3.6 Mine Ventilation System

#### Ventilation Raise Sites

The regulations of ventilation systems within underground mines in the United States are set by the U.S. Department of Labor, Mine Safety and Health Administration (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 area (with two intake raises) and ventilation raise site 1 and ventilation raise site 3 would function as the exhaust raises (Figure 2-2 and Figure 2-11). 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 ventilation system requirements. The ventilation raises would be constructed by raise bore technique. Dedicated ventilation drifts and internal raises would be established to transfer fresh and exhaust air from the production levels to the ventilation raises. Underground booster fans would be installed, as required, at the top of the fresh air transfer raises to support ventilation in the deeper parts of the mine.

Air would also exhaust through the conveyor and access declines. To serve as a third exit from the underground mine, an Alimak elevator (or a comparable product) would be installed in one of the intake ventilation raises.

Air intake and exhaust monitoring would be installed as necessary.

#### Level Controls

Airlocks, vent doors, regulators, and bulkheads would be used to ensure proper control of the air entering areas of the mine. In each extraction level, the proposed ventilation design considers an intake and exhaust source, with more air entering the level than exhausting through the return raise system.

#### Mine Heating

Due to the Project location, heating of the underground workings would likely be required from November through March or April. To heat the mine, TMM would use propane gas-fired air heaters located on the surface at ventilation raise site 2 (Figure 2-11). Fresh air would initially enter the heater house and pass through a direct-fired propane heater before being ducted to the main intake raise. A single propane tank storage facility for the heater stations would be located in close proximity to both heater stations, as illustrated on Figure 2-11. 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. Heaters are not required in the declines.

### 2.3.7 Underground Facilities

#### First Aid Stations

First aid stations would be distributed throughout the underground working areas. They would provide first-aid supplies for the care of minor injuries and for the stabilization of major injuries prior to transport to the surface. Stations would also contain communication equipment. First aid stations would be placed in excavations previously used as muck bays as well as in close proximity to refuge chambers.

#### Explosive Magazines

Underground explosive magazines would be excavations consisting of multiple bays to store: emulsion in portable cassettes; initiation caps and detonator cords; and high explosives (e.g., boosters, primers, and stick cartridge powder). Designated utility vehicles would transport explosives materials from the surface to the underground explosive magazines. The underground explosive magazines have been designed for a minimum of two days of explosive material storage. Storage and transport of explosives materials would be done in accordance with the MSHA, the U.S. Department of Justice, Bureau of Alcohol, Tobacco, Firearms and Explosives, and the Minnesota State Fire Marshall. Explosive magazines would have locked doors to restrict personnel access and would be in designated non-smoking areas. All magazines would be ventilated directly into an exhaust airway.

#### Underground Mobile Equipment

**Primary Mining Equipment**

Primary mining equipment would include the mobile equipment directly involved in the mining cycle including underground development and the haulage of muck and ore. The estimated primary mining equipment is listed in Table 2-4.

**Secondary Mining Equipment**

Secondary mining equipment would include equipment necessary for the safe and efficient continuation of the mining cycle but not directly involved in the mining cycle. Estimated secondary mining equipment would include:

- Cable bolters, shotcrete transmixers, and sprayers for ground support;
- Grader and water truck for roadway maintenance and dust suppression;
- Scissor lifts, boom trucks, and transmixers for underground construction;
- Mobile fuel and lubricant trucks to service mobile equipment; and
- Personnel carriers and light vehicles for transportation of workers, supervisors, and technical personnel.

**Fuel and Lubrication Bays**

Three underground fuel and lubrications bays, each including storage tanks and dispensing stations, would service the underground mining operations. Fuel would be delivered to the bays via a fuel pipeline delivery system. The fuel transfer pipeline from the surface would use an automated batch transfer system with automated valves to direct fuel to the demand location. The amount of fuel stored at each location would vary depending on the equipment schedule. At a minimum, each would have the capacity to store one day's usage.

Lubrication oils and grease totes would be transported underground to the fuel and lubrication bays. All fuel and lubrication bays would include fire suppression systems.

Underground fuel / lube trucks would be available to service equipment at the development and production faces. This includes drill jumbos, production drills, bolters, graders, shotcrete spray units, and portable compressors.

**Satellite Maintenance Workshops**

Satellite maintenance workshops would provide light mechanical repairs for slower moving mobile equipment (e.g., jumbos, bolters, and production drills). Satellite workshops would be constructed underground as required to minimize travel delays and facilitate equipment turnaround times. Lubrication oil and grease totes would be transported underground to the satellite maintenance workshops, as needed.

**Communication Systems**

Underground communications would be based on a redundant backbone system along the conveyor and access declines and main ramps by means of fiber optic and leaky feeder. A leaky feeder system consists of a coaxial cable which emits and receives radio waves like an extended antenna. The extension of communication systems to the extraction and drilling areas would be with a leaky feeder system.

A fiber optic system would allow for the communication of live video feed from the crushers and conveyors, surveillance video from explosive magazines and backfill bulkheads, plus data from control rooms.

The leaky feeder system would carry all radio and internet protocol signals (with the use of modem converters). The leaky feeder system would also connect and pass information to the fiber optic system for faster and more reliable communication.

Radios would be installed in underground equipment and handheld radios would be issued to supervisors and crew leads.

Anticipated communications systems may be modified and/or upgraded as practicable and necessary based on available technologies.

**Refuge Chamber**

In the event of an emergency, refuge chambers would provide mine workers with a safe atmosphere for up to 36 hours. Refuge chambers are discussed in Section 2.3.7.

**Lavatories**

Portable lavatories (blue rooms) would be supplied for the underground operations and would be placed in close proximity to general work areas. Sewage from the blue rooms would be collected via vacuum pump trucks, transported to the surface, and disposed of off-site by a licensed third-party contractor.

**Office and Waiting Areas**

The underground office and waiting area would include a break room with drinking water and tables, as well as a small office space for supervisors to complete administrative work for the underground operations.

**Fire Detection System**

The underground mine would be equipped with a fire alarm, control and suppression system as required.

**Power Distribution**

For the underground mine, electrical power would originate at the portals and be routed down the declines to the main underground switchgear. From the main switchgear, distribution lines would distribute power throughout the underground mine.

Localized underground transformers would step the power down to usable voltages. The feeders for underground services would be sized to provide redundant service for the major ventilation equipment and other equipment critical to personnel safety or production.

Electrical power to the vent raises would be supplied through the underground distribution lines, so as to limit the need for surface facilities and minimize surface disturbance footprints.

## 2.4 Plant Site

The overall process flow diagram is presented in Figure 2-12.

### 2.4.1 Ore Storage Facilities

There would be two ore storage facilities on the surface: the coarse ore stockpile and the temporary rock storage facility.

#### Coarse Ore Stockpile

The concentrator would be fed with ore from the coarse ore stockpile where it would be reclaimed by the coarse ore reclaim conveyor (also known as the semi-autogenous [SAG] mill feed conveyor). The coarse ore stockpile would primarily be fed by run of mine ore from the decline conveyor via the coarse ore stockpile feed conveyor but would also be supplemented with ore from the pre-operational ore stockpile during the first two years of operation and intermittently supplemented with ore from the overflow ore stockpile during operational years three through 25.

The coarse ore stockpile would have a concrete working floor with a reclaim area underneath the working floor, and a covered geodesic dome structure. The coarse ore stockpile would be approximately 94 ft tall and would have the capacity to store up to three days of crushed ore. Covering the coarse ore stockpile would reduce dust emissions, prevent infiltration of stormwater into the ore, and would reduce the risk of ore freezing during winter operations.

Material from the coarse ore stockpile would be fed into the concentrator via the SAG mill feed conveyor. Ore stored in the coarse ore stockpile would already be crushed and would be fed directly to the SAG mill within the comminution circuit without additional crushing. The coarse ore stockpile's geodesic dome would be located beneath the coarse ore stockpile feed conveyor to reduce the visibility of the dome. Primary access would be along the SAG mill feed conveyor. A secondary escape would be included in the tunnel under the coarse ore stockpile which would contain the apron feeders and a portion of the SAG mill feed conveyor.

#### Temporary Rock Storage Facility

The temporary rock storage facility would be a lined facility with water management features which would capture stormwater on the footprint of the facility to direct it to the central contact water pond. At the central contact water pond, the water would be pumped to the process water pond for process use. Throughout the life of the Project, two stockpiles would be managed on the temporary rock storage facility: the pre-operational ore stockpile and the overflow ore stockpile.

The temporary rock storage facility would be lined with an 80 mil linear low-density polyethylene (LLDPE) or engineer-approved alternate geomembrane liner, overlain by 12 inches (300 millimeters [mm]) of compacted low permeability soil, and 12 inches (300 mm) of sand (Figure 2-13).

**Pre-operational Ore Stockpile**

Ore extracted during mine development would be temporarily stockpiled as the pre-operational ore stockpile located on the surface on the temporary rock storage facility. The pre-operational ore stockpile would be processed through the concentrator as part of the feed material for concentrator ramp-up and initial production.

Once the concentrator is commissioned, the pre-operational ore stockpile would be re-handled, crushed at a temporary surface crushing facility, and fed into the coarse ore stockpile via conveyors for processing through the concentrator. The pre-operational ore stockpile would be temporary and at its largest size (1.2 Mst) at the end of the mine construction period. The pre-operational ore stockpile would be consumed through the process within the first two years of operations. Design parameters for the pre-operational ore stockpile are included in Table 2-5.

**Overflow Ore Stockpile**

After processing the pre-operational ore stockpile on the temporary rock storage facility, a portion of the temporary rock storage facility would be used to manage the overflow ore stockpile. The overflow ore stockpile would operate with a capacity of up to 2.5 days of crushed ore and would be used intermittently throughout the mine operation. The overflow ore stockpile would serve to decouple the underground mine and process plant during shutdowns. Shutdowns would occur due to both planned and unplanned maintenance.

When the coarse ore stockpile is temporarily full, crushed ore would be directed via conveyor to the overflow ore stockpile. When space is available in the coarse ore stockpile, ore in the overflow ore stockpile would be reclaimed by front end loader before being placed on the temporary rock storage facility reclaim conveyor and directed to the coarse ore stockpile feed conveyor via the surface transfer station. Intermittent use of the overflow ore stockpile would be based on the maintenance schedule of both the underground mine and the process plant.

### 2.4.2 Surface Conveyors

**Coarse Ore Stockpile Feed Conveyor**

The coarse ore stockpile feed conveyor would transfer ore to the coarse ore stockpile from either the decline conveyor or the temporary rock storage facility / overflow ore stockpile reclaim conveyor via the surface transfer station. The coarse ore stockpile feed conveyor would be equipped with a weather cover to reduce freezing, noise, and dust emissions. The coarse ore stockpile feed conveyor would be self-supported and would be mechanically and structurally independent of the coarse ore stockpile’s geodesic dome. The coarse ore stockpile feed conveyor would have enough clearance to drive trucks beneath in designated areas.

**Temporary Rock Storage Facility Reclaim Conveyor**

When processing ore from the pre-operational ore stockpile during startup of the concentrator, the temporary rock storage facility reclaim conveyor would feed crushed ore from the temporary crusher near the temporary rock storage facility to the coarse ore stockpile feed conveyor via the transfer station. This conveyor would be used intermittently during operations.

**Temporary Rock Storage FAcility Feed Conveyor**

When the coarse ore stockpile is full, ore from the decline conveyor would be diverted to the overflow ore stockpile on the temporary rock storage facility via the transfer station and temporary rock storage facility feed conveyor. This conveyor would be used intermittently during operations to feed the overflow ore stockpile.

**Coarse Ore Reclaim / SAG Mill Feed Conveyor**

Ore would be reclaimed from the coarse ore stockpile by two apron feeders and would be discharged onto the SAG mill feed conveyor. The SAG mill feed conveyor would transfer ore to the concentrator building from the coarse ore stockpile. The SAG mill feed conveyor would be equipped with a weather cover and water spray dust control system at transfer points.

### 2.4.3 Concentrator Building

The concentrator building would include the comminution circuit, flotation circuit, concentrate dewatering, concentrate storage and loadout, and the reagent makeup area (Figure 2-5). These areas are located inside the building and are sited together to allow for a centralized control room and better control of the processing. The concentrator control system is discussed in Section 2.4.7. Buildings on surface, including the concentrator building, would be equipped with a fire alarm, control and suppression system as required.

### 2.4.4 Comminution Circuit

The comminution circuit would be located within the concentrator building. The comminution circuit would use a SAG mill and ball mill configuration to reduce the particle size of the ore prior to the flotation circuit. Within the comminution circuit would be the gravity recovery circuit to recover gold, platinum, and palladium. The major sub-circuits of the comminution circuit are further discussed in this section. The grinding circuit and gravity circuit are further discussed in this section.

A bridge crane would span the concentrator building to service the SAG mill, ball mill, and SAG discharge screen. Another bridge crane would service the gravity concentrate circuit. A liner handling machine would be required for the SAG mill. The grinding circuit and bridge cranes have been designed to reduce the height and subsequent visibility of the concentrator building.

**Grinding Circuit**

The SAG mill feed conveyor would convey ore from the coarse ore stockpile to the SAG mill to be processed. Ore from the coarse ore stockpile along with recirculated oversize material would feed the SAG mill. The SAG mill discharge would be screened and oversize pebbles would be conveyed and reintroduced to the SAG mill feed on the SAG mill feed conveyor. Recirculation conveyors for oversize material would be contained within the building to keep the wet ore on the conveyor belt inside the building to prevent potential freezing during winter. SAG mill discharge material which passes through the screen would have achieved the target grind size from the SAG mill circuit and would be directed to the ball mill circuit.

The ball mill circuit would grind ore to a $P_{80}$ of 135 microns before the ore is pumped to the flotation circuit. The ball mill would be operated in a closed-circuit configuration to achieve a tight particle size distribution. The ball mill circuit would be fed from the product of the SAG mill circuit (the screened undersized material from the SAG mill discharge) combined with material being recirculated to the ball mill (the ball mill recirculating load). This stream would then be classified through a cyclone with the cyclone overflow as the product of the circuit being pumped to the flotation circuit. The cyclone underflow would be recirculated to the ball mill to be ground and further reduced in size.

A portion of the ball mill recirculating load would be split and fed to the gravity concentration circuit before returning to the ball mill circuit.

**Gravity Concentration Circuit**

A portion of the ball mill recirculating load would be split equally to feed multiple gravity concentration units operating in parallel. The gravity concentration units would operate in batch to recover gold, platinum, and palladium based on the higher specific gravity of the minerals to the gravity concentrate. The gravity concentrate would be dewatered while the gravity tailings would be returned to the ball mill recirculating load.

The gravity concentrate would flow in batches to a gravity concentrate holding tank. The gravity concentrate would be dewatered and transferred to concentrate bags or other containers. The concentrate bags or containers could be stored or loaded onto trucks for transport.

### 2.4.5 Flotation Circuit

The flotation circuit would produce two concentrates: the copper concentrate and the nickel concentrate. Through the copper flotation circuit, copper, gold, silver, platinum, and palladium would be recovered while minimizing the amount of nickel and cobalt recovered. Through the nickel flotation circuit, nickel, cobalt, and the remaining copper, platinum, palladium, gold, silver, and the remaining sulfides would be recovered.

The copper and nickel flotation circuit would be located in the concentrator building and would include a copper rougher bank, nickel rougher bank, copper and nickel regrind mills, copper cleaners, and nickel cleaners.

**Copper Rougher**

Overflow from the ball mill cyclone feed cluster would be directed to the copper roughers. Reagents would be added to the copper rougher bank to promote flotation of copper minerals. Through flotation, a majority of the copper minerals would be recovered into a copper rougher concentrate while the material that does not float would report to the copper rougher tailings. The copper rougher tailings would still contain the majority of nickel minerals and some left over copper minerals. The copper rougher tails would be sent to the nickel rougher bank to recover nickel and cobalt minerals and the remaining copper minerals. The copper rougher concentrate would be pumped to the copper concentrate regrind mill for particle size reduction prior to grade improvements through counter-current cleaning.

**Copper Regrind**

The copper rougher concentrate would be further reduced in particle size to increase liberation before being fed to the copper cleaning circuit.

**Copper Cleaners**

The copper regrind mill discharge would feed the copper cleaner circuit. The copper cleaner circuit would include two stages of counter current cleaning where the copper concentrate grade would be improved to target product specifications. The final concentrate would be pumped to the copper concentrate dewatering circuit and the copper cleaner tailings would be pumped to the nickel regrind circuit.

**Nickel Rougher**

The copper rougher tailings would feed the nickel rougher. Reagents would be added to the nickel rougher bank to promote flotation of nickel and cobalt minerals and the remaining copper minerals. Through flotation, nickel and cobalt minerals and the remaining copper minerals would be recovered into a nickel rougher concentrate while the material that did not float would report to the nickel rougher tailings. At this point, the nickel rougher tailings would contain no more recoverable metal or recoverable sulfide minerals and would be pumped to the tailings dewatering plant in preparation for placement on the lined dry stack facility or use as backfill material. The nickel rougher concentrate would be recovered and sent to the nickel regrind circuit.

**Nickel Regrind**

The nickel rougher concentrate would be further reduced in particle size to increase liberation and would then be combined with the copper cleaner tailings before being fed to the nickel cleaning circuit.

**Nickel Cleaners**

The nickel regrind mill discharge would feed the nickel cleaner circuit. The nickel cleaner circuit would include three stages of counter current cleaning where the nickel concentrate grade would be improved to target product specifications. At the end of the first stage of nickel cleaning, the final cells would act as a scavenger to keep recoveries high. The final concentrate would be pumped to the nickel concentrate dewatering circuit and the nickel cleaner tailings would be pumped to the thickener at the tailings dewatering plant.

### 2.4.6 Concentrate Dewatering and Storage

The final copper concentrate and final nickel concentrate would each be dewatered and stored in circuits dedicated to each concentrate to prevent cross contamination.

**Copper and Nickel Concentrate Dewatering**

The final concentrates from the flotation circuit would first be dewatered through dedicated concentrate thickeners to remove a majority of the water and produce thickened concentrates. The thickeners would be located inside the concentrator building to prevent freezing during winter months

The thickened concentrates would be fed to dedicated concentrate filter presses. The filter presses would reduce the moisture in the concentrates and allow the concentrates to be stockpiled and then transported by truck, rail, or ship. Filtered concentrates would be discharged to the dedicated storage and loadout area.

Filtrate from the concentrate filter presses would be returned to the concentrate thickeners to further clarify the water. Thickener overflow water would be used to make up immediate process water needs in the concentrator with the excess being sent to the process water pond where it would be reused for processing of ore at the concentrator.

**Copper and Nickel Concentrate Storage and Loadout**

The filtered copper and nickel concentrates would drop into their respective loadout areas. To prevent cross contamination, the concentrates would be handled by dedicated front end loaders to load either copper or nickel concentrate into their respective concentrate trucks. The loadout areas are designed for three days of storage each of copper and nickel concentrate.

### 2.4.7 Plant Site Surface Infrastructure and Ancillary Facilities

#### Mine Services Building

The mine services building would include a truck shop, mine dry, and warehouse. The mine services building would be centrally located and would be shared by technical services, supervision, and hourly labor for the underground mine (Figure 2-5).

The truck shop portion of the mine services building would service underground vehicles, maintenance service vehicles, and some utility vehicles. Although some minor maintenance would be performed underground in satellite maintenance workshops by underground service vehicles, most maintenance would require mobile equipment be brought to the surface. Haulage trucks, powder trucks, and services vehicles would drive out of the underground mine to the truck shop using their own power. Others, such as development and production drills, loaders, and bolters would be transported out of the underground mine to the truck shop on low-boy trailers. Light vehicles would generally be serviced off-site, or as time and space allots, at the plant site. The truck shop portion of the mine services building would host the following facilities:

- Overhead crane;
- Wash bays;
- Lubricant and oil storage;
- Welding bay;
- Tool crib; and
- Space allotted outside for parking vehicles.

Engine oil and lubricants would be provided in oil cubes and stored in dedicated areas near the mine services building. Primary fuels for the Project are provided in Table 2-6. These would be stored in dedicated areas on surface and within the underground mine.

The mine dry portion of the building would host the following facilities:

- Mine personnel drys with clean and dirty sides (complete with baskets);
- Laundry staging area (laundry would be collected for cleaning by a third-party contractor);
- First aid / security;
- Storage;
- Offices adjacent to an open concept area for technical services;
- Lunch / training room;
- Space for daily safety meetings; and
- Mine rescue training and storage room.

The warehouse portion of the building would host the following facilities:

- Storage area for mine equipment maintenance spares;
- Small office for the receivables team;
- Truck unloading dock; and
- Storage with shelving.

**Concentrator Services Building**

The concentrator services building would be located near the concentrator building and would provide a workshop to perform routine and non-routine maintenance on concentrator building equipment, as well as store critical and non-critical spares (Figure 2-5). The concentrator services building would host the following:

- Maintenance workshop, including a machine shop, welding shop, tool crib, mechanical room, overhead cranes, and electrical repair room;
- Indoor warehouse facility with unloading dock and shelving;
- Locker and change facilities for process operators;
- Offices, both on the ground floor and in an elevated floor on the north side of the building; and
- Lunch and training rooms.

The concentrator services building would also include an attached covered work area and a fenced storage area.

**Process and Contact Water Facilities**

The process water facilities are discussed in Section 2.13.3 and contact water facilities are discussed in Section 2.13.5.

**Reagent Storage**

Reagents for flotation and thickening would be made up in an extension of the concentrator building near the flotation circuit (Figure 2-5). Reagents delivered in bulk solution would have dedicated storage tanks within the extension. Reagents delivered in bulk bags would be stored in the fabric-covered reagent storage building adjacent to the concentrator services building. Lime would be stored in a silo outdoors and would be integrated with the detention slaker. The minimum reagent storage would be one week, except for lime which would be approximately 4.5 days. Primary reagents required for mineral processing are provided in Table 2-7.

**Grinding Ball Storage**

Grinding media would be shipped to the site via bulk transport and stored in ball bunkers which would provide up to four weeks of storage. The grinding ball storage would be near the concentrator building, as shown on Figure 2-5.

**Laboratory**

Metallurgical and geological assays would be contracted to a third-party laboratory in the region. An on-site laboratory would be located in the concentrator building and would be used for grinding tests, flotation tests, and geotechnical tests.

**Gatehouse**

The access road would provide access to the northern portion of the plant site, where a staffed gatehouse would control access as shown on Figure 2-5.

**Tire Wash**

Roads within the plant site would be divided into contact roads and non-contact roads, as related to water management. Contact roads would be used for mine operations and non-contact roads would be used for site navigation and are intended for use by vehicles not directly related to production or maintenance.

Vehicles which use a contact road must go through the tire wash before exiting back to the non-contact roads to prevent possible contaminants from leaving the site. The tire wash would be located near the parking area as shown on Figure 2-5.

**Snow Storage**

During winter months, snow would be plowed into designated snow storage areas (Figure 2-5). 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).

**Ready Line**

When not in use, haul trucks and other mobile mine equipment would be temporarily staged at the ready line located near the mine services building as illustrated on Figure 2-5. The equipment would be parked here during shift changes and when requiring light maintenance. The area would be lit at night for safety.

**Parking**

Employees would be bussed to the site from the administration building located in Babbitt (Section 2.19.1) or from a parking lot in Ely and would not require parking spaces within the plant site. Parking areas would be located adjacent to the mine services building and concentrator services building for use by supervisory staff, project technical staff, contractors, and consultants.

**Laydown Areas**

Equipment and materials not requiring climate-controlled storage would be stored in construction laydown areas. Sea containers and temporary shelters may be used for goods that require weather protection. Laydown areas would be located throughout the plant site. Laydown areas during both construction and operation would be designated within the plant site or tailings management site as appropriate.

**Mine Water Supply**

Mine water supply is discussed in detail in Section 2.12.

**Explosive Magazines**

Explosives would be temporarily stored on the surface prior to transport to the underground explosive magazines. The location of the surface explosive magazine is shown on Figure 2-5.

**Shotcrete Plant and Aggregate Stockpile**

The shotcrete plant and aggregate stockpile would be located to the east of the coarse ore stockpile. The shotcrete plant would consist of a mobile mixing unit for maximum operational flexibility. The shotcrete plant would be erected on steel foundations.

Shotcrete would be used in the underground workings. Cement trucks would be filled with shotcrete on the surface and driven underground to required locations.

**Reclamation Material Stockpiles**

Suitable growth medium, which includes topsoil, peat, and mineral soil, would be stripped from the site and stockpiled for future reclamation efforts.

Topsoil would be stored in two stockpiles at the plant site (reclamation material stockpile 1 and reclamation material stockpile 2 as illustrated on Figure 2-5). Topsoil stripping at the plant site is estimated to produce 111,200 cubic yards ($yd^3$) (85,000 cubic meters [$m^3$]) of material based on soil surveys of the area. Plant site reclamation material stockpile dimensions are shown in Table 2-8.

During clearing and grubbing, 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. Waddles would also be placed around the base of the reclamation material stockpiles for stormwater control. Additional woodchips would be strategically placed in the laydown yards for future use.

**Communication System**

On-site communications would be conducted through a fiber-optic system. The fiber-optic system would be connected to major buildings. Vehicle communications would be provided by short wave radio in surface vehicles for communication to operations.

Off-site communication would be performed primarily by cell phone and voice over internet protocol. The communication system for underground operations would rely on fiber optic, leaky feeder, and radios as discussed in Section 2.3.7. The mine communication system would be integrated with the mine's control system.

**Control System**

The plant site would be monitored and controlled from a central control room located in the concentrator building and the tailings management site would be monitored and controlled from a satellite control room located in the filter plant. A process control system would be integrated across the entire site and would provide different monitoring, control, and access permissions for different areas.

**Surface Mobile Equipment**

Surface mobile equipment would support the plant site, tailings management site, and general surface operations. Surface mobile equipment are identified in Table 2-9. Note, the surface mobile equipment does not include mobile equipment for services that TMM plans to contract such as employee bussing and snow removal.

**Fuel and Lubricant Storage**

Diesel and gasoline for the plant site would be stored near the mine services building within the fuel storage area (Figure 2-5). A gasoline tank would allow fueling of surface equipment and/or light vehicles. The diesel tank would be sized to allow for a minimum of one week of consumption for both surface and underground users. The diesel and gasoline would be stored in appropriately sized containment areas in accordance with state and federal regulations. The gasoline and diesel tanks would have a local dispenser.

Diesel would be pumped to the portal in batches and gravity-fed to the underground storage tanks via a fuel pipeline delivery system installed in the conveyor decline, as described in Section 2.3.7. The system would include controls and instrumentation to ensure safety interlocks and transfer protocols are observed.

Propane would be used to heat the mine and Project facilities. Propane storage for heating of the underground workings would be located at ventilation raise site 2 (Figure 2-11) and provide for a minimum of three days of use, as discussed in Section 2.3.6. Propane for heating other facilities would be located adjacent to the concentrator building (Figure 2-5).

**Electrical Substation and Mine Electrical System**

**Plant Site Power Distribution**

A TMM-owned transmission line would supply power to the plant site electrical substation. Distribution across the plant site and tailings management site would utilize underground raceways, cable trays, and overhead power lines to connect the following areas:

- Concentrator building;
- Backfill plant building;
- Filter plant building;
- Mine services building;
- Concentrator services building;
- Coarse ore stockpile;
- Portals and declines;
- Underground mine; and
- Other lesser ancillary facilities.

Electrical equipment, motors, control panels, field devices, relay control system components, and cabling systems would be approved for the environmental conditions in which the equipment would be installed. Oil-filled electrical equipment (transformers, switch gear, etc.) would be certified polychlorinated biphenyl free before being brought on-site.

**Backup Power**

In the event of a power outage, production would be halted and backup power would be provided for emergency services 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. Backup power loads would be controlled through the process 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 critical equipment such as fans for safe ventilation.

Uninterruptable power supplies would be used to provide backup power to critical control systems. This equipment would be sized to allow operations to shut down and back up the computer and control systems and to facilitate start-up on restoration of normal utility power. Emergency battery power packs would supply back-up power to the fire alarm system and emergency egress lighting fixtures.

### Telecommunications

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.

**Fencing**

Fencing would be installed around the plant site, tailings management site, and associated solution ponds, as necessary. Additionally, infrastructure such as the ventilation raise sites and the water intake facility would be fenced to control access. Fencing specifications would be in accordance with guidance set forth by the MDNR and USFS.

## 2.5 Tailings Management Site

As discussed in Section 2.4.5, tailings from the nickel rougher would be pumped from the concentrator to the tailings dewatering plant which includes the tailings thickener, filter plant, filter cake storage and storage loadout building, and backfill plant.

### 2.5.1 Tailings Thickener

The tailings thickener would be located adjacent to the filter plant (Figure 2-7). The tailings supply line would follow a service road connecting the plant site and the tailings thickener. In addition to the tailings supply line, power, water supply, and water return lines would be routed alongside the service road connecting the plant site and the tailings thickener. The Project would be capable of producing 100% tailings filter cake for the lined dry stack facility, 100% engineered tailings backfill backfill, or different proportions of each.

A flocculant reagent would be added to the tailings thickener to aid in the tailings settling and dewatering. The thickened tailings from the tailings thickener underflow would be sent to the filter plant for further dewatering. Tailings filter cake from the filter plant would then be placed on the lined dry stack facility or sent to the backfill plant and combined with a binder for use as engineered tailings backfill in the underground workings in different proportions depending on operational needs.

The tailings thickener would be a steel supported above-ground structure and, should a loss of containment occur, slurry would flow to a lined emergency pond located adjacent to the thickener (Figure 2-7).

The filter plant is discussed in Section 2.5.2 and the backfill plant is discussed Section 2.5.4.

### 2.5.2 Filter Plant

The filter plant would be located in the northwest corner of the tailings management site adjacent to the tailings thickener, backfill plant, and the filter cake storage and loadout building (Figure 2-7). 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 tailings filter cake in the target range of 84% to 87% solids. The tailings filter cake would be transported via short-run conveyors to either the backfill plant or the filter cake storage and loadout building.

### 2.5.3 Filter Cake Storage and Loadout Building

The filter cake storage and loadout building would receive tailings filter cake from the filter plant via a belt conveyor which would deposit the material onto a radial stacker. The radial stacker would be used to create a stockpile with up to 1.5 days of tailings storage capacity as a tailings filter cake (Figure 2-7). The stockpile would be enclosed in the heated building to prevent dust, rewetting due to stormwater, and freezing due to cold temperatures. Front end loaders would transfer the stockpiled tailings filter cake material from the stockpile into haul trucks which would transport the tailings filter cake to the lined dry stack facility. A haul road would exist alongside the filter cake storage and loadout building and would be used as the transportation route to the lined dry stack facility.

### 2.5.4 Backfill Plant

Tailings thickener underflow which bypasses the filter plant would be recombined with tailings filter cake, sent to the backfill plant, and blended with a binder for use as engineered tailings backfill in the underground workings (Figure 2-7). Blended tailings from the backfill plant would be delivered as engineered tailings backfill to mined out stopes in the underground workings via a pipeline distribution system utilizing positive displacement type pumps. Additional information regarding backfill is included in Section 2.3.4.

### 2.5.5 Dry Stack Facility

The lined dry stack facility would provide permanent storage of tailings filter cake and would be located within the tailings management site (Figure 2-7). The dry stack facility footprint preparation and construction is discussed in Section 2.16.4. The dry stack facility would be developed by placing and compacting approximately 106 Mst (96 Mt) of tailings filter cake, which amounts to approximately 60% of the total tailings which would be generated by the Project. The lined dry stack facility would have a tailings storage footprint area of 429 acres (174 hectares [ha]) to the toe of the dry stack facility (edge of tailings). 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. Associated features would be located around the perimeter of the dry stack facility, including ponds and ditches to manage contact water, a groundwater cutoff wall, haul roads, and a reclamation material stockpile.

As discussed in Section 2.5.3, tailings filter cake would be transported from the filter cake storage and loadout building to the lined dry stack facility by haul trucks travelling over constructed haul roads. The tailings filter cake would be dumped by the haul trucks on the dry stack facility, levelled by dozers, and compacted with vibratory roller compactors or other equipment as required. The exterior side slopes 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. Benches would provide a location for collection channels and would be graded towards regularly spaced discharge chutes extending down the slopes of the dry stack facility, that would be constructed as part of the reclamation landscape. Overall, the filtered tailings would be compacted and placed at grades and contours that would promote drainage, prevent ponding, and allow for stability in post-closure.

The lined dry stack facility would consist of a zone of densely compacted tailings filter cake around the full perimeter of the facility which would provide increased structural stability. This structural zone would include the final perimeter slope and a 33 ft (10 m) -wide crest around the perimeter. Tailings filter cake in the interior of the lined dry stack facility (non-structural zone) would be moderately compacted. A typical cross section of the lined dry stack facility is included as Figure 2-14. A typical cross section of the perimeter contact water ditch and groundwater cutoff wall associated with the lined dry stack facility is included as Figure 2-15. Contact and process water management for the lined dry stack facility is discussed in Section 2.13.5.

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 design of the 4H:1V exterior slopes and well-compacted tailings in the structural zone would provide long term stability around the perimeter of the dry stack facility. 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.

As portions of the slope and crest of the dry stack facility are constructed, the completed surfaces would be concurrently covered and reclaimed. The dry stack facility cover is anticipated to consist of a cover soil as a suitable growth medium, underlain by a hydraulic barrier. Reclamation of the dry stack facility is discussed in Appendix B.

In order to achieve geotechnical requirements, dry stack facility construction would not proceed during extremely wet periods (heavy rain or snowmelt) or during extremely cold periods as the tailings must be compacted prior to freezing.

### 2.5.6 Wash / Spray Station

The wash / spray station would be a concrete pad with a sump located south of the filter plant (Figure 2-7). The wash / spray station would be used to clean equipment prior to maintenance, transport, or storage.

### 2.5.7 Monitoring

Vibrating wire piezometers and slope inclinometers would be installed along the exterior slopes of the lined dry stack facility. These instruments would monitor pore pressure response and movement in the dry stack facility. If monitoring shows an unacceptable rise in pore pressure, then pore pressure would be allowed to dissipate before placement of additional material on the dry stack facility. Similarly, if the slopes of the dry stack facility show an unacceptable amount of movement, then remedial measures would be implemented to improve stability.

Specific protocols for monitoring of the lined dry stack facility would be carried out in accordance with a Project monitoring plan.

### 2.5.8 Reclamation Material Stockpile

During site preparation of the lined dry stack facility, suitable growth medium, which includes topsoil, peat, and mineral soil, would be stripped from the site and stockpiled for future reclamation activities.

Organic soil and mineral soil would be stored separately, but in the same stockpile area, designated as the tailings management site reclamation material stockpile (Figure 2-7). During reclamation, the organic soil and mineral soil would be blended or placed in layers, to a minimum thickness of two ft (0.6 m), depending on the reclamation cover soil design. Based on preliminary estimates of depth to bedrock and organic soil thickness, it is estimated that 502,000 $yd^3$ (384,000 $m^3$) of organic soil (topsoil and peat) and 878,000 $yd^3$ (671,000 $m^3$) of mineral soil would be stripped and stockpiled.

Construction of the dry stack facility infrastructure would be completed in three stages. As such, not all of the soil would be stripped during initial construction. In addition, because the dry stack facility would be concurrently reclaimed throughout the operational period of the mine, reclamation material would be regularly removed from the reclamation material stockpile. The maximum size of the reclamation material stockpile would be 871,000 $yd^3$ (666,000 $m^3$) in Year 16 and would be less than the total volume of stripped material. Tailings management site reclamation material stockpile dimensions are shown in Table 2-10.

### 2.5.9 Power Distribution

Power distribution to the tailings management site would be via overhead power lines from the plant site electrical substation. The power lines would follow the service road connecting the plant site and tailings management site and would terminate at the E-house switch yard located adjacent to the filter plant (Figure 2-7). Power would be distributed from the E-house switch yard to facilities within the tailings management site including the filter plant, backfill plant, and the filter cake storage and loadout building.

Power would be distributed to contact water ponds as necessary to power the pumps. Power distribution would follow the service road around the dry stack facility perimeter to the various tailings management site contact water ponds.

## 2.6 Non-Contact Water Diversion Area

The non-contact water diversion area would consist of a system of dikes and diversions to divert non-contact water around the plant site and the tailings management site (Figure 2-2, Figure 2-5, and Figure 2-7). Water supply and management is discussed further in Section 2.12 and specifics are included in the Project's non-contact water management plan (Appendix C).

## 2.7 Access Road

The access road is depicted in Figure 2-2 and discussed in Section 2.2.2. The access road would be a two-lane, gravel road with 14 ft (4.3 m) -wide lanes for a total road width of 28 ft (8.6 m). The access road construction limits would be approximately 200 ft (61 m) wide, depending on corridor grading limits. Ditches would be provided for stormwater runoff control, and culverts would be sized to accommodate 100-year, 24-hour storm event.

## 2.8 Water Intake Corridor

The water intake corridor would extend from the plant site westward to Birch Lake reservoir and would terminate at the water intake facility. The water intake corridor would include a pipeline, buried power line, and a gravel single-lane access road. The typical layout of the water intake facility is included as Figure 2-16, and the water intake facility plan, profile, sections, and details are illustrated in Figure 2-17.

The water intake corridor construction limits would be approximately 100 ft (30.5 m) - wide depending on corridor grading limits. The water intake facility would be located a minimum of 100 ft (30.5 m) from the shore of Birch Lake reservoir. An intake pipeline would extend from the water intake facility into Birch Lake reservoir and a screened, low-flow intake (0.5 feet per second or less) would be located at the end of the intake pipeline, approximately 550 ft (170 m) away from the shore of Birch Lake reservoir. The intake pipeline (approximately 18 inches in diameter) would enter the water a minimum of 3 ft (1 m) below the water level, lay on the bottom of the lake, and would draw water from a depth of approximately 15 ft (4.6 m) at the end of the pipeline (Figure 2-17). From the low-flow intake, water would be pumped via the water intake facility to the plant site where it would be used as make-up water for Project operations.

## 2.9 Transmission Corridor

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, as illustrated on Figure 2-2. The transmission corridor construction limits would be approximately 150 ft (46 m) wide, depending on corridor grading limits. Transmission corridor maintenance width would be 150 ft (46 m) or less. Construction of the transmission corridor is provided in Section 2.16.5 and an illustrative cross section of the transmission corridor is included as Figure 2-9.

## 2.10 Production Schedule

The current mine plan utilizes 61% of ore reserves in federal mineral leases, 36% in state mineral leases, and 3% in private mineral leases over a 25-year operational mine life. Mineral leases and land ownership information for surface and mineral resources are included in Appendix A.

Over the currently proposed 25-year operational mine life, approximately 180 Mst (163 Mt) of ore would be extracted from the underground mine. Table 2-11 and Table 2-12 summarize the mine plan over the 25-year operational mine life by production and resource category, respectively. Figure 2-18 summarizes the mine plan by lease owner type. Due to the ore body shape, the underground mine was divided into five major mining production zones, as illustrated in Figure 2-19, Figure 2-20, and Figure 2-21. Initial development would focus on Zone 1. After achieving full production, the mining progression would continue toward Zone 2 through Zone 5. Figure 2-22 illustrates the mine plan over the 25 years of active mining by zone.

## 2.11 Staffing

The Project would operate 24 hours a day, 365 days a year. Shifts will comply with all lease and permitting terms and conditions. It is anticipated that mine and processing personnel would work two, 12-hour shifts on a four-day-on / four-day-off shift rotation schedule and processing supervisors would work on a 12.5-hour day to cross over with the next shift rotation. Management and administration staff would work weekdays, eight hours per day. Exceptions would exist for specific technical staff and operators, as necessary and determined by their job responsibility.

Table 2-13 presents the anticipated number of employees required for the Project. TMM anticipates that most workers would be hired locally, with incentives for relocation required only in the case of specialized expertise.

## 2.12 Rock Management

TMM would manage mined rock based on three rock categories:

- Ore: rock mined from the basal mineralized zone (BMZ) that contains the targeted metals – copper, nickel, cobalt, platinum, pallidum, gold, and silver – which would be recovered through the concentrator to three concentrates;
- Development rock: sulfide barren rock mined from the hanging wall that would be used for construction aggregate. Development rock would be mined during the construction of the declines and ventilation raises, and periodically throughout the project. Development rock would be used as construction aggregate to meet fill requirements; and
- Waste rock: rock mined during operations below the targeted cut-off grade that would be managed underground and placed in mined out stopes for permanent storage.

The material characterization program would further define the rock types and their suitable uses. Development rock would be tested to confirm its geochemical suitability for use as fill based on guidelines to be developed in the material characterization program. Section 5.3 discusses the current status of TMM's material characterization program summarizing key findings and presents a future work scope for the continued development and execution of the material characterization program.

During the construction phase, as the mine declines and ventilation raises approach the BMZ, mined rock would be monitored and tested to determine the cut-off point where sulfide mineralization begins. When sulfide mineralization begins, this would represent the "end" of the development rock. During the construction phase, rock with sulfide mineralization would be handled as ore. Ore mined during the construction phase would be temporarily stockpiled on surface in the pre-operational ore stockpile at the temporary rock storage facility. The temporary rock storage facility is described in Section 2.4.1. The pre-operational ore stockpile would be processed when the concentrator begins operating. No rock would be categorized as waste rock during the construction phase because there would be a lower ore cut-off grade during the construction phase than during the operation phase.

During the operation phase, ore would be crushed underground and transported by conveyor to the coarse ore stockpile. Rock mined during operations that is below the cut-off grade, would be treated as waste rock. This waste rock would be managed underground by placing the waste rock in mined out stopes prior to backfilling with engineered tailings backfill.

At no point in time throughout the construction or operation phases would waste rock be transported to the surface; rock transported to surface would either be classified as ore (and processed through the concentrator) or development rock (and used as construction aggregate).

Through Project design and rock management strategy, acid rock drainage (ARD) potential from the two most common ARD sources associated with mines of this type (waste rock stockpiles and tailings) has been avoided. First, the Project would not have permanent waste rock stockpiles on the surface, due to the underground mining and processing strategy of ore, thus avoiding the potential for ARD from permanent waste rock stockpiles on surface. Second, the Project would recover most sulfides from the ore, producing a tailings with sulfur less than 0.2% S. Testwork on Duluth Complex tailings, including Maturi ore tailings from the Project's pilot plant, has demonstrated this level of sulfur to be non-acid generating. Geochemical characterization results are summarized in Section 5.3.

## 2.13 Water Supply and Management

TMM would manage water to avoid and minimize environmental impacts subject to appropriate federal and state agency oversight. Overall, water would be routed from the underground workings 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 reservoir 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 reservoir; 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.

Water would be managed in four categories:

- Process water – water that would be used in the process to grind the ore and recover the targeted metals;
- Contact water – water, in the form of direct precipitation or stormwater, that would potentially come in contact with ore or tailings, but has not been used in the process or combined with process water;
- Non-contact water – water that would not come in contact with ore or tailings; includes water from adjacent watersheds that would be diverted around the facility; and
- Construction stormwater: direct precipitation or stormwater that has contacted surfaces disturbed during construction, but that has not contacted ore.

TMM is continuing to evaluate appropriate management of other forms of industrial stormwater.

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; and
4. Make-up water from Birch Lake reservoir.

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.

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 reservoir. Water from Birch Lake reservoir would be withdrawn on an as-needed basis when the process water demand could not be met by available mine inflow and contact water in storage. The average withdrawal from Birch Lake reservoir 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 gpm and would be stopped when other sources of water meet water demands. To put the withdrawal into context, 800 gpm is equivalent to approximately 30 garden hoses.

Specific water supply and management facilities and features are discussed in the following sections.

### 2.13.1 Mine Supply Water Storage

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 tank and the sediment pond when available (Figure 2-5). The mine water tank would have a capacity equivalent to a four-hour supply of service water. Level sensors in the tank would be used to monitor and control the tank water level. The mine supply water system would not be connected to the underground fire suppression system, which is handled separately.

### 2.13.2 Contact Water Ponds

Three contact water ponds would be located within the plant site to manage stormwater as contact water which has contacted process components. These ponds include the:

- North contact water pond;
- South contact water pond; and
- Central contact water pond.

Five contact water ponds and two interim contact water ponds would be located within the tailings management site to manage surface water which has contacted process components. These ponds include:

- Tailings management site contact water pond 1;
- Tailings management site contact water pond 2;
- Tailings management site contact water pond 3;
- Tailings management site contact water pond 4;
- Tailings management site contact water pond 5;
- Interim tailings management site contact water pond; and
- Interim tailings management site contact water pond 2.

Contact water pond locations are illustrated in Figure 2-5 and Figure 2-7 for the plant site and tailings management site, respectively. The ponds would be sized to contain 100-year, 24-hour storm event. In addition, the collective storage capacity of the contact water ponds for the lined dry stack facility during operation would be sized to meet the stormwater runoff requirements from a 100-year snowpack. Each pond's catchment area and dimensions are provided in Table 2-14. The contact water ponds would be single lined with a 60 mil high density polyethylene (HDPE) or engineer-approved alternate geomembrane liner over a 1-foot (300 mm) thick, low-permeability, compacted soil layer. The soil layer would be compacted to meet maximum hydraulic conductivity requirements of not more than $1 \times 10^{-6}$ centimeters per second (cm/sec). A typical cross section of the contact water pond liner is illustrated in Figure 2-23. Major inflows for each pond would include inflows of catchment stormwater runoff and pond direct precipitation. Major outflows for each pond would include pond evaporation, pumping to another pond, or use in the process. Ultimately, these contact waters would be managed through the process and contact water management system, as discussed in Appendix D and Section 2.13.5.

### 2.13.3 Process Water Storage

The process water management strategy would be to prioritize water use for processing by the following list:

1. Reuse of process water;
2. Use of mine inflow (classified as process water as it would mix in the underground mine dewatering system);
3. Use of contact water; and
4. Make-up water from Birch Lake reservoir.

#### Process Water Pond

The process water pond would be the central collection and distribution point for water used during the processing of ore at the concentrator. Water recycled from the process, contact water ponds, underground dewatering, and makeup water supply from Birch Lake reservoir via the fresh/fire water tank would ultimately be collected in and distributed from the process water pond. The process water pond location is illustrated in Figure 2-5. The process water pond would be double lined with leak detection and would be designed for year-round operation. The liner system would consist of a 60 mil HDPE or engineer-approved alternate geomembrane liner underlain by a geocomposite drainage layer, a 40 mil HDPE or engineer-approved alternate geomembrane liner, and a 1-foot (30.5 cm) layer of compacted material. A typical cross section of the process water pond liner is illustrated in Figure 2-23.

The pond volume would be approximately 18,500,000 gal (70,000 $m^3$). The process water pond would be sized to contain direct precipitation from the 100-year, 24-hour storm event with appropriate freeboard.

#### Process Water Tank

The process water tank would act as surge control between the process water pond and the concentrator and would store approximately 264,000 gal (1,000 $m^3$) of water. Level sensors in the tank would be used to monitor and control the tank water level.

#### Process Area Fresh/Fire Water Tank

The fresh/fire water tank would hold approximately 264,000 gal (1,000 $m^3$) and would be located near the concentrator building. Level sensors in the tank would be used to monitor and control the tank water level, as well as control the number of raw water supply pumps being used at any one time. The fresh/fire water tank would be supplied with water from Birch Lake reservoir via the water intake facility and water intake corridor.

Water from the fresh/fire water tank would be used in the process, as well as the underground mine-wide service water distribution system. A minimum volume of approximately 180,000 gal (680 $m^3$) of fire water would be maintained in the bottom section of the fresh/fire water tank. Fire water pumps would be located in the concentrator building. The volume of water which would be maintained for fire water is based on a sprinkler demand of 2,000 gallons per minute (gpm) (454 cubic meters per hour [$m^3$/hr]) for one hour and a hose demand of 500 gpm (114 $m^3$/hr) for two hours.

**Process Area Potable Water**

A modularized potable water treatment system would provide potable water to the mine services building, concentrator building, and concentrator services building. The water for this system would be sourced from the fresh/fire water tank. The location of the modular potable water supply system and tank is illustrated on Figure 2-5.

**Sediment Pond**

Underground mine water would be pumped from the underground workings, de-oiled on the surface using oil-water separators, and clarified in the sediment pond at the plant site. The sediment pond would have the same liner design as the contact water ponds and would overflow into the process water pond. The sediment pond location is illustrated on Figure 2-5.

The mine dewatering rate would be up to 53,000 gallons per hour (gal/hr) and variable over time. A portable slurry pump would be used to periodically sluice sediment from the sediment pond to the filter plant or other appropriate location. The sediment pond would have a volume of 1,268,000 gal (4,800 $m^3$) and would be sized to require clean-up less than once a year to coincide with concentrator maintenance. Depending on the characterization of the sediment, the sediment removed would either be placed on the dry stack facility or disposed of off-site appropriately.

### 2.13.4 Process Water

As discussed in Section 2.13.3, water recycled from the process circuit, contact water ponds, underground mine water, and makeup water supply from Birch Lake reservoir via the fresh/fire water tank would ultimately be collected in and distributed from the process water pond for use as production water. Process water would be used during the operational phase of the Project.

Additional make-up water would be drawn from Birch Lake reservoir via the water intake pipeline in order to maintain the process water pond at a target volume to provide sufficient surge capacity to balance make-up water requirements. Facilities associated with the water intake pipeline are discussed in Section 2.8, and illustrated on Figure 2-5.

### 2.13.5 Surface Water Management

The site non-contact water management plan is included as Appendix C and the site contact and process water management plan is included as Appendix D.

#### Contact and Process Water

**Process Water Management**

As discussed in Section 2.13.3, the process water pond would be the main supply of water to the concentrator and underground mine. Project water management would maximize reuse of water and the process water pond would be refilled by underground mine water pumped from the underground workings, contact water ponds, recycled process water, and make-up water from Birch Lake reservoir. Design specification for the process water pond are discussed in Section 2.13.3.

Due to the designed management and in accordance with 40 CFR § 440 the system is a closed loop and the Project would not require discharge of process or contact water.

**Plant Site Contact Water Management**

To prevent contact water from leaving the plant site to the surrounding environment, the plant site would be graded to collect contact water in the contact water ponds (Figure 2-5). Ultimately, contact water ponds within the plant site would be directed to the process water pond and managed through the process water management system, as discussed in Section 2.13.2. Details and dimensions of the contact water ponds within the plant site are included in Section 2.13.2.

Additional information regarding contact and process water management for the plant site is included in Appendix D.

**Tailings Management Site Contact Water Management**

The tailings dewatering plant area would be graded during Project construction so that stormwater and meltwater runoff would flow to the south and into tailings management site contact water pond 1.

Contact water runoff from the lined dry stack facility would be captured in contact water ditches installed around the perimeter toe of the dry stack facility. A typical cross section of the exterior slope of the dry stack facility showing the contact water system is shown in Figure 2-15. The contact water ditches would also serve to collect potential draindown, defined as seepage from the tailings or stormwater which has infiltrated the tailings after placement.

Construction of the lined dry stack facility is discussed in Section 2.16.4. The design of the lined dry stack facility, specifically the above-liner drains and the blanket toe drain would be intended to capture draindown at the base of the dry stack facility, diverting draindown to the contact water ponds via the contact water ditches, and controlling the phreatic surface. The primary purpose of the under-liner drain would be to reduce potential underlying groundwater pressure exerting uplift on the geomembrane liner. A secondary purpose of the under-liner drain would be to function as an environmental protection measure to capture potential seepage through the liner for the dry stack facility. The under-liner drains would discharge to the perimeter contact water ditches and any discharge would be managed as contact water. Seepage through the membrane to the underdrain 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, the quantity and quality of seepage has not been calculated for the design will be addressed as a future scope of work. In addition to the liner, over-liner, and under-liner drains, the dry stack facility would include the construction of a groundwater cutoff wall to protect groundwater. The groundwater cutoff wall would include a compacted soil seepage cutoff trench through the overburden soil beneath the perimeter haul road, and construction of a grout curtain below the trench, installed if required through zones of fractured or weathered upper bedrock.

The over-liner and under-liner drains, the liner, the contact water ditches, the groundwater cutoff wall, and the outer haul road would be constructed concurrently with the dry stack facility stages. Stage 1 of the dry stack facility would require the construction of tailings management site contact water pond 1, tailings management site contact water pond 2, and the interim tailings management site contact water pond 1. Stage 2 would require the construction of tailings management site contact water pond 3 and interim tailings management site contact water pond 2. Stage 3 would require the construction of tailings management site contact water pond 4, and contact water pond 5. Contact water collected in the contact water ponds would either be pumped to the process water pond for use as process water, used as dust control on the temporarily exposed surfaces of the dry stack facility, or used for filter cloth wash as available.

Design of the contact water ponds at the tailings management site is discussed in Section 2.13.2.

<u>**Non-Contact Water**</u>

**Plant Site Non-Contact Water Management**

A portion of the plant site would be managed as a non-contact area to allow flexibility for water management during extreme storm events. The non-contact area at the plant site would include, the security gatehouse, reclamation material stockpile 1 and 2, the plant site electrical substation, the ball storage bunker, the concentrator, the concentrator services building, the reagent storage building, and the areas surrounding and connecting these facilities that are not directly involved in transport of ore or tailings by truck. Based on the operational water needs for the process at the time of storm events, water from the non-contact area would be either diverted away from the plant site to minimize the amount of contact water collected from the plant site or collected by the contact water collection system.

Additional information regarding non-contact water management for the plant site is included in Appendix C.

**Tailings Management Site Non-Contact Water Management**

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

- Tailings management site reclamation material stockpile;
- 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;
- Portion of the tailings dewatering plant; and
- Reclaimed portion of the dry stack facility.

Non-contact water management within these areas would be accomplished through the use of infrastructure such as diversion dikes, sediment ponds, non-contact water ditches, and other water management infrastructure. A full description of the non-contact water management within these five areas of the tailings management site can be found in Appendix C.

## 2.14 Transportation and Conveyance

Transportation and conveyance is addressed in the Project's transportation plan located in Appendix E.

## 2.15 Waste Management

The Project would produce solid wastes, sanitary wastes, and some hazardous wastes. All wastes would be disposed of in accordance with federal, state, and local regulations. Tailings management is discussed in Section 2.5.

### 2.15.1 Solid Waste

Non-hazardous solid wastes generated at the Project would be collected in trash cans and dumpsters. Dumpster removal and disposal would be provided by a licensed waste disposal contractor. Metal, glass, plastic, and paper would be recycled, as practicable.

### 2.15.2 Sanitary Waste Handling

Sewage and sanitary liquid wastes would be collected and disposed of off-site by a licensed, third-party contractor.

### 2.15.3 Hazardous Waste

Hazardous solid and liquid wastes would be collected and temporarily stored on-site prior to off-site shipment to storage and disposal facilities in accordance with Resource Conservation and Recovery Act (RCRA) regulations. Hazardous waste would be transported in U.S. Department of Transportation (DOT)-approved containers to permitted hazardous waste treatment, storage, and disposal facilities. In the event of a release of a hazardous material, hazardous solid wastes would be contained, mitigated, and reported in accordance with the site spill contingency plan, included in Appendix F. Prevention, containment, and cleanup measures in the spill contingency plan would minimize the potential for related impacts to soils, vegetation, wildlife, and water resources.

## 2.16 Construction Phase

### 2.16.1 Construction Schedule

The Project schedule is described in terms of quarters (Q) with: Q1 being January, February March; Q2 being April, May, June; Q3 being July, August, September; and Q4 being October, November and December. Construction years are referred to as Year -3 to Year -1. Construction would occur during a 2.5-year period, from quarter Q3 of Year -3 to Q4 of Year -1, as illustrated on the construction schedule in Figure 2-24. This period would include time for construction of surface facilities and initial underground infrastructure construction. The construction phase would end with the commissioning of the concentrator, commencement of underground mining operations, and concentrate production.

### 2.16.2 Construction Access

An existing USFS road would provide immediate access to begin site clearing and grubbing activities and portal construction at the plant site. Existing USFS and exploration roads over the underground mine would also serve as access to the ventilation raises during construction. Existing USFS and county roads would provide construction access to the transmission corridor (Figure 2-2).

### 2.16.3 <u>Clearing and Grubbing</u>

Prior to beginning construction activities, the Project area would be cleared and grubbed and topsoil and peat would be stripped from the areas and stockpiled for reclamation, as described in Section 2.4.7. During clearing and grubbing, saleable lumber would be harvested and sold by a licensed, USFS-approved third-party contractor. The remaining plant matter would be chipped and used to cover the reclamation material stockpiles to prevent wind and water erosion. Additional woodchips would be strategically placed in the laydown yards for future use during Project reclamation activities.

### 2.16.4 <u>Dry Stack Facility</u>

The dry stack facility would be developed in three stages from west to east. Development would begin during the construction phase and would continue through the 25 years of operation. Each stage would begin by constructing the dry stack facility infrastructure followed by tailings filter cake placement. Tailings filter cake placement would occur during operations as described in Section 2.5.5. The following discussion relates to the construction of the dry stack facility infrastructure which would include: a liner system (under-liner drains, geomembrane liner, over-liner drains), contact water ditch, groundwater cutoff wall, haul road, and associated contact water ponds.

Construction of the dry stack facility stage 1 infrastructure would occur from Q3 of Year -3 through Q4 of Year -1. For each stage of infrastructure construction, the dry stack facility site would be prepared by clearing and grubbing vegetation, draining standing water and preparing the subgrade, which would consist of removing sharp rocks and other debris and then proof-rolling the foundation subgrade soils. Where bedrock is exposed, it would be covered with a minimum six-inch thick (15 mm) bedding layer of compacted local borrow material. The footprint of each dry stack facility construction phase dry stack facility would include a prepared foundation with gravel under-liner drains, a 60 mil thick LLDPE or engineer-approved alternate geomembrane liner, and over-liner drains. The contact water ditch, groundwater cutoff wall, and haul road would be installed around each dry stack facility stage. An illustration of Stage 1 construction is included as Figure 2-25. An illustration showing surface reliefs of the original ground, and dry stack facility at the end of Stage 1, Stage 2, and Stage 3 (after placement and compaction of tailings) are included as Figure 2-26. Phased development and reclamation of the dry stack facility is discussed in Section 2.5.5. The phased construction of the contact water ponds is discussed in Section 2.13.5.

### 2.16.5 <u>Transmission Corridor</u>

The transmission corridor would include an overhead electric transmission line which would be constructed concurrently with other Project facilities, 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. TMM expects two work fronts: one starting at the plant site; and one starting at the off-site electrical substation identified on Figure 2-2. The transmission corridor construction limits would be approximately 150 ft (46 m) -wide. Transmission line structures would be placed in such a way as to avoid wetlands and sensitive habitats, as practicable. An illustrative cross section of the transmission corridor is included as Figure 2-9.

### 2.16.6 Water Intake Corridor

The water intake corridor would include a pipeline, power line, and a maintenance road with a water intake pump house near Birth Lake reservoir. These features be constructed concurrently with other Project facilities in the same manner as described for the transmission corridor with the following exceptions: construction from one front starting at the plant site, and the water intake corridor construction limits would be approximately 100 ft wide.

### 2.16.7 Plant Site Surface Infrastructure

The setup of temporary surface facilities would begin during excavation of the portal. The following list indicates the temporary facilities to be used during construction, as illustrated on Figure 2-27:

- Portal pond;
- Heater;
- Gensets;
- Exhaust fans at the portal;
- Temporary surface crushing facility;
- temporary rock storage facility;
- Transfer station and feed hopper;
- Temporary equipment parking;
- Tramp metal / debris stockpile;
- Cold storage warehouse;
- Truck wash;
- Shops;
- Water tank;
- Wash facility septic tank;
- Office;
- Mine dry;
- Mine rescue room;
- Light vehicle parking;
- Fuel day tank; and
- Blasting magazines.

### 2.16.8 Portal and Mine Decline Development

Portal and decline development would occur from Q4 of Year -3 through Q4 of Year -2. The portals would be excavated using drill and blast in two benches. To minimize overbreak on the excavation walls, presplitting methods would be used. After the portal excavations are completed, loose rock would be scaled and bolted to ensure safe access. The portals would then be constructed of corrugated steel on parallel concrete curb foundations. The entire box cut would be backfilled with engineered fill which would come from on-site or off-site sources.

The decline would then be keyed in for a minimum distance of 50 ft (15 m).

During construction, the two declines would be the primary ventilation source for the underground mine until the first vent raise is constructed and commissioned.

### 2.16.9 Underground Mine Development

Primary objectives of underground mine construction would include the development of ramps and haulage areas, and development of access to the first ore production areas. Secondary underground mine construction objectives would include the excavation of drifts for backfill and ventilation, establishment of the ventilation circuit and dewatering systems, and development of satellite workshops, fueling stations, and explosives magazines.

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. When the ventilation raise is drilled during the construction phase, the rock would be handled as development rock and thus transported to surface for use as construction aggregate.

### 2.16.10 Ore Stockpiling - Temporary Rock Storage Facility

As discussed in Section 2.4.1, ore produced during construction would be temporarily stored in the lined temporary rock storage facility until the concentrator is constructed and commissioned.

### 2.16.11 Development Rock and Construction Materials

Construction of the plant site platforms would advance as development rock is generated during excavation of the declines. Major foundations would be on excavated bedrock, and platforms for construction access and laydown would be developed as excess development rock becomes available.

Although crushed development rock from the mine declines is likely to be suitable for structural backfill, road surfacing, and concrete aggregate after crushing and blending, a third-party contractor would transport granular materials needed for drains, structural backfill, concrete aggregate, and bedding layers to the Project area, as necessary.

### 2.16.12 Concentrator and Tailings Dewatering Plant

Construction of the concentrator and tailings dewatering plant, which includes the tailings thickener, filter plant, tailings filter cake storage and loadout building, and the backfill plant, would begin in Q3 of Year -3 and would be complete by Q3 of Year -1. Concentrator and tailings dewatering plant construction would begin with the procurement, fabrication, and delivery of major equipment.

### 2.16.13 Equipment

Construction equipment would generally include the surface mobile equipment identified for Project operations in Section 2.4.7, as well as the primary and secondary underground mining equipment identified in Section 2.3.7. Other equipment which would be required for clearing and grubbing, as well as general civil earthworks would include:

- Bulldozers;
- Scissor lifts;
- Cranes;
- Compactors;
- Liner handling machines;
- Excavators; and
- Additional drills.

### 2.16.14 Electrical Equipment and Materials

Electrical power during the construction period is expected to be provided by on-site diesel generators (gensets). During construction, these gensets would be located northeast of the portal area. Grid power would be delivered to the site by the start of equipment commissioning and continue through operations and into closure.

### 2.16.15 Construction Stormwater Management

Construction activities would be conducted in accordance with the Minnesota Construction Stormwater General Permit, following best management practices (BMPs) in an agency approved Storm Water Pollution Prevention Plan (SWPPP). Contact water generated during construction would be discharged, as required, in compliance with permits.

#### 2.16.16 Construction Labor

In total, approximately three million labor-hours would be required to construct the Project. Fluctuations in the total hours would likely occur due to the seasonal nature of constructing the lined dry stack facility or other bulk earthwork projects.

#### 2.16.17 Temporary Housing Needs

Temporary housing (i.e. temporary trailer parks or man camps) would not be required.

## 2.17 Site Operations Security and Safety

### 2.17.1 Security

As discussed in Section 2.4.7, a staffed security gatehouse would control primary access to the site. The location of the gatehouse is shown on Figure 2-5.

### 2.17.2 Employee Health and Safety

TMM holds the safety and health of team members, contractors, suppliers, and neighboring communities as a core organizational value. As such, TMM would require compliance with applicable health and safety regulations, TMMs safety and health management system, and the TMM safety policy.

During operations, training for new employees would include TMM specific training in addition to required MSHA training as outlined in 30 CFR § 48 subparts A and B. Training for the operation of specific equipment would also be required. To support this need, mining equipment manufacturers would train future operators in the specifics of new equipment as part of the equipment purchase contract and TMM, with the help of mining equipment manufacturers, would develop specific training plans as described in 30 CFR § 48.3 and 48.23. Similarly, process operator training would be augmented with simulators and shadowing of experienced operators.

TMM is a participating member of the National Mining Association's CORESafety initiative, which serves as a framework to ensure compliance with the regulatory requirements of the Occupational Safety and Health Administration (OSHA) and the eventual transition to the MSHA requirements applicable to TMM's future operations. TMM also utilizes the International Council on Mining and Metals Critical Control Management Implementation Guide to ensure alignment with internal safety and health requirements.

Health and safety standards or procedures to be applied at the Project are described in the OSHA 1910 General Industry Standards (OSHA, 2019a), OSHA 1926 Construction Standards (OSHA, 2019b), applicable U.S. Federal Metal and Nonmetallic Mine Safety and Health Standards in 30 CFR for Surface and

Underground Mines (USDL, 2019) from MSHA, and relevant state and local statutes and regulations.

**<u>TMM Safety Policy</u>**

The TMM Safety Policy would apply to Project team members throughout the Project's construction, operation, and closure phases, including contractors, suppliers, and visitors. The TMM Safety Policy would be communicated to team members by appropriate TMM personnel on an ongoing basis.

TMM's Safety Policy has been developed using the following strategies:

- Assessing potential health hazards and safety risks as early as possible;
- Preventing or effectively controlling potential safety risks beginning with the Project's design and continuing through mine closure and post-closure;
- Investigating health and safety incidents and implementing action plans to prevent recurrence;
- Allocating sufficient time, money, and focus to operate safely; and
- Communicating about health and safety performance openly and honestly.

### 2.17.3 Safety Evaluation

TMM would maintain an internal risk register for the Project based on the severity and likelihood of potential risks and consequences. The results from risk assessments would be included in the risk register.

If Project-related industrial hygiene risks are identified, TMM would consult with an industrial hygiene specialist to determine exposure limits and controls or corrective measures to eliminate or minimize exposure risk.

**<u>Safety Support Systems</u>**

The underground mine would rely on three safety support systems: a centralized blasting system, a production equipment dispatch system, and a general personnel and equipment asset tracking system. The combination of the three safety support systems would allow for efficient and safe operation.

**Centralized Blasting System**

The centralized blasting system would work in conjunction with the proposed digital leaky feeder system to provide full, two-way blast control for underground applications. This system would allow blasting to be initiated a safe distance from the blasting site (e.g. from the surface for the blasting of stopes). The centralized blasting system would rely on remote and master devices, the latter allowing control over multiple remote devices at a time.

**Equipment Dispatch**

An equipment dispatch system would allow for the efficient and timely assignment of resources to tasks in the mine. The system would enable dispatch for main production equipment of the mine including jumbos, bolters and production drills, powder trucks, LHDs, shotcrete sprayers, transmixers, and production trucks.

**Asset Tracking System**

For safety purposes, the asset tracking system would provide the identification and location of personnel and assets throughout the Project. Specifically, check-points would be located underground to acquire the position of personnel and equipment. While the system would not be meant to track exact locations, the reference to checkpoints would be sufficient in the event of an emergency.

### 2.17.4 Fire and Emergency Planning

**Steady-State Operation**

Evacuation plans would be developed for structures including the mine services building, concentrator, filter plant, backfill plant, filter cake storage and loadout building, process services building, and the underground mine, as well as other structures that might require evacuation during an emergency. These plans would outline the procedures that should be followed in the event of fire or other emergency requiring evacuation and would define responsibilities of key personnel. Evacuation maps that show suggested evacuation locations and emergency response routes would be posted at strategic locations throughout the site.

During production, there would be three exits from the underground mine. The access decline would be the primary escape route and the conveyor decline would be the secondary escape route for mine personnel. A third exit would be through one of the ventilation raise shafts. An elevator would be installed to support emergency evacuations in this location.

As specified in in Section 2.3.7, refuge chambers would provide a safe atmosphere for up to 36 hours in the event of an emergency. MSHA requires that refuge chambers be located so that mine personnel can reach them within 30 minutes from their work area. The refuge chambers would be portable and would be relocated accordingly as mining progresses. Additionally, mine rescue teams would be available as per 30 CFR § 49 Subpart A,

**Emergency Communications and Stench Warning System**

Radio would be the primary means of communication during an emergency. Mine equipment would be radio-equipped. Radios would also be installed at first-aid stations and refuge chambers.

A stench gas warning system would be used as a secondary emergency warning method. In the event of an emergency, stench gas would be injected into the ventilation raises. The stench gas system would be activated automatically as part of evacuation procedures, or from the central control room or central dispatch.

## 2.18 Exploration

No surface exploration programs are planned to occur within the Project area during Project operations. If exploration becomes necessary in the future, TMM would pursue exploration permitting activities separately from this MPO.

## 2.19 Off-Site Ancillary Facilities

### 2.19.1 Administrative Buildings in Ely and Babbitt

Administration buildings would be located off-site in Ely and Babbitt, Minnesota. Busses would transport the majority of hourly personnel from the administration buildings to the Project as described in the transportation plan (Appendix E).

# 3.0 ENVIRONMENTAL SETTING

## 3.1 Land Use and Zoning

### 3.1.1 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 reservoir 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 (approximately 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 and Ely, Minnesota);
- Fire management; and
- Recreation.

The land within the Project area is managed for multiple uses, including mineral resource development. Mineral development in the region is discussed in Section 2.1.

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. Additionally, the Project is outside of the state minerals management corridor adjacent to the BWCAW (Figure 3-1). 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, golf; and
- Recreational trails.

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.

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 3-2). 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. 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.

There are no prime or unique farmlands, agricultural preserves, or conservation lands in the Project area.

### 3.1.2 Planned Land Use

There are six land use management plans which 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); and
- Land and Resource Management Plan for the SNF (USFS, 2004); and
- Northern Superior Uplands Section Forest Resource Management Plan (MDNR, 2015 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 3-3. Figure 3-4 show private parcels of land within Lake and St. Louis counties subject to local land or water management plans. Additionally, this figure identifies the nearest residences, which are associated with the South Kawishi Association (SKA) located to the north and west of the Project. These residences are the nearest sensitive receptors to the Project. Figure 3-5 shows federal parcels of land subject to the Land and Resource Management Plan for the SNF.

**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.

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

**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 with the Project area located within a Tier 2 area. 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.

**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."

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

#### 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 Superior National Forest Land and Resource Management Plan for the SNF. The purpose of the plan is to "guide all natural resource management activities for the Superior National Forest". The plan provides direction, goals, and implementation guidance intended to influence day-to-day management and long-term management of the SNF.

#### 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. The Northern Superior Uplands Section Forest Resource Management Plan is in the process of being drafted with an anticipated completion date of 2019 according to information available on the MDNR website. The state forest management units within the Project area would be subject to the Northern Superior Uplands Section Forest Resource Management Plan.

### 3.1.3 Current Zoning and Management Codes

There are four zoning authorities associated with the Project area; City of Babbitt, Lake County, St. Louis County, and MDNR. Local zoning controls apply to the portions of the Project area within private ownership. Federal and state lands are not subject to local zoning controls but are governed by federal and state rules and regulations. A comprehensive map of local zoning districts applicable to the Project area are illustrated on Figure 3-3. This figure also identifies the Shoreland Zoning areas surrounding water basins (Birch Lake reservoir) and water courses (Keeley Creek, Denley Creek, and Stony River) within the Project area subject to additional shoreland zoning requirements. Figure 3-4 identifies parcels of land within the Project area subject to local zoning (Lake County, St. Louis County, Babbitt).

In addition to the zoning authorities, there are two primary 1854 Treaty area management entities:

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;
- 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.

## 3.2 Geology, Soils, and Topography / Land Forms

The Project area is underlain by the geologic group referred to as the Duluth Complex which is composed of magmatic (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 3-6. 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 (around 1,850 million years old) iron-formation, clastic, and carbonate metasedimentary rocks of the Animikie Basin.

### 3.2.1 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 magmas related to the Midcontinent Rift System and makes up much of 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 on the southwest by the Partridge River Intrusion, on the northwest by the GRB and Biwabik Iron Formation, the Anorthositic Series to the northeast, and on the southeast by the Bald Eagle Intrusion. 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 3-7. A bedrock geology map of the Project area is shown on Figure 3-8 and cross sections of the deposit are shown on Figures 3-9 through 3-12.

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.

### 3.2.2 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. In some localities along the shoreline of Birch Lake reservoir, 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 five to 20% of the area (Ericson et al., 1976).

### 3.2.3 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).

### 3.2.4 Structure

Rock units and mineralization in the BMZ are planar and sub-parallel to the lower contact with an average strike of approximately 60 degrees (°) and dips of 20° to 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.

### 3.2.5 Soils and Topography / Landforms

The Project area is within the Nashwauk Uplands (212Lc) and Border Lakes (212La) subsections of the Northern Superior Uplands (NSU) 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 reservoir, 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 200 ft (61 m). Project area topography is shown on Figure 3-13.

#### 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 3-14. Map unit descriptions, physical soil properties, hydric soil, soil engineering properties, including information on corrosion susceptibility and frost heave potential are described in Table 3-1. 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.

**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 3-15. 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 3-2.

**Monitor Well Data**

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. Monitor well records indicate most unconsolidated deposits range from 0 to 20 ft (0 to 6 m) thick near the underground mine area.

## 3.3 Paleontological Resources

The underground mine, plant site, and the tailings management site lie within an area comprised of magmatic (igneous) rocks, and rocks within the Project area which pre-date complex life forms. As such, paleontological resources are not anticipated to occur within or around the Project area.

## 3.4 Water Resources

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

### 3.4.1 Surface Water

#### Watersheds and Waterbodies in the Vicinity of the Project Area

The Project area would be located north of the Laurentian Divide with water flowing north towards Hudson Bay. The U.S. Geological Survey (USGS) defines this at a broad scale as the Rainy Headwaters (Hydrological Unit Code-8 [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 3-16 and MDNR watershed boundaries are shown on Figure 3-17.

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 3-16. Table 3-3 shows the area of Project features within the HUC12 and MDNR watersheds.

Birch Lake reservoir 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 reservoir through the South Kawishiwi River. Birch Lake reservoir has a maximum depth of 25 ft (7.6 m) and the water level can drop by as much as four 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 reservoir and Fall Lake.

Public waters basins and watercourses within the vicinity of the Project area are listed in Tables 3-4 and 3-5.

#### Hydrology

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

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 Filson Creek and Keeley Creek.

A stream morphology assessment has been conducted for the site. Stream types were classified under the Rosgen classification system as either Type E or C.

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 Reservoir Water Level

Birch Lake reservoir water level is at an elevation of roughly 1,414 ft (431 m) amsl. The water level on Birch Lake reservoir is controlled by a dam operated by Minnesota Power at the northern most end of the lake where it drains into White Iron Lake reservoir 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 reservoir. Dam operation results in a winter drawdown of about 4 ft.

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

### Surface Water Quality

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

#### 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 total suspended solids, 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 (meq/L). 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 one to two microgram per liter [µg/L]). Other trace metals of biological importance, including arsenic, cadmium, cobalt, mercury, and lead have median concentrations significantly below one 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 reservoir, 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**

There are two Minnesota Pollution Control Agency (MPCA) 303d Impaired Waters within one mile of the Project:

- Birch Lake reservoir for aquatic consumption-mercury in fish tissue; and
- Keeley Creek for aquatic life-fishes' bioassessments.

### 3.4.2 Groundwater

This section identifies the hydrogeologic units in the vicinity of the Project area, summarizes baseline hydrogeologic characteristics and groundwater quality, and identifies groundwater use in the vicinity of the Project area.

#### Hydrogeologic Units in the Vicinity of the Project Area

Hydrogeologic units (HGUs) 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:

- Quaternary Unconsolidated Materials (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 and GRB 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 3-18.

#### Groundwater Quality

This section provides an overview of regional groundwater quality.

**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 chemistry 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 Superior National Forest. 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 composition 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.

**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 3-19. Twenty-five private and public water wells are located within 1 mile (1.6 km) of the underground mine, plant, and tailings management site areas as identified in the Minnesota Well Index (MWI). Wells registered with in the MWI are shown on Figure 3-20.

### 3.4.3 Wetlands

This section describes the available data sources and 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 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 environmental assessment worksheet by Environmental Quality Board guidance.

#### 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 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.”

**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 3-6, and shown on Figure 3-21. 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.

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%), Shrub Wetland (8.5%), and Open Bog (8.1%) (Kloiber et al., 2019). Descriptions of each wetland type can be found in the report *Wetland Plants and Plant Communities of Minnesota and Wisconsin* (Eggers and Reed, 2015).

**Circular 39 Classification System**

Baseline acreages of wetlands in the Project area, calculated using the Circular 39 classification system, are listed in Table 3-7, and shown on Figure 3-22. 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.

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). Descriptions of the Circular 39 wetland types can be found in the report *Wetlands of the United States - Their Extent and Their Value to Waterfowl and Other Wildlife* (Shaw and Fredine, 1971).

## 3.5 Hazardous, Toxic, and Radiological Waste

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.

## 3.6 Terrestrial and Aquatic Resources

Terrestrial and aquatic resource baseline conditions were examined within the Project area using multiple sources. The specific resources summarized in this section include land cover, habitat, ecosystems, fish, wildlife, and vegetation including sensitive species.

### 3.6.1 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 reservoir.

The Project area has a history of mineral exploration and mining, as described in Section 2.1. 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.

**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 Ecological Classification System, the USGS Gap Analysis data, and the USGS National Land Cover Database.

**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 3-23. 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, 2019c).

**USGS Gap Analysis Project / 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 3-24 (USGS, 2011a). 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 3-8.

**USGS National Land Cover Database**

The National Land Cover Database 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 National Land Cover Database land cover types are shown on Figure 3-25 and are broken down by Project components in Table 3-9.

These different classifications are defined in the *GAP / LANDFIRE National Terrestrial Ecosystems 2011* (USGS, 2011b).

**MDNR Minnesota Biological Survey**

The classification of baseline terrestrial resources within the Project area also considered the presence of native plant communities.

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.

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 3-26. Approximately 650 acres (263 ha) of the southwestern extent of the transmission corridor are unmapped (MDNR, 2019d). 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 3-10. Overall, upland communities cover approximately 70% of the Project area with wetland community types at 30% of the Project area.

<u>**Vegetation**</u>

**Sensitive Species**

There are 65 sensitive terrestrial vegetative species potentially present in the Project area (one fungus, 14 lichen, four moss, and 46 vascular plants) as summarized in Table 3-11. The species' federal and state statuses, Regional Forester Sensitive Species (RFSS) status, Species in Greatest Conservation Need (SGCN) status, recorded occurrences within the Project area in the Minnesota Natural Heritage Information System (NHIS) data, and listed habitats are also provided in Table 3-11. Descriptions for each of the species within the Project area are available from the MDNR Rare Species Guide (MDNR, 2019e).

The approximate locations of documented occurrences of sensitive vegetative and terrestrial species occurrences have been documented as shown on Figure 3-27.

**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. Johnswort (*Hypericum perforatum*), 43 instances of common tansy (*Tanacetum vulgare*), and five instances of spotted knapweed (*Centaurea biebersteinii*).

The Minnesota Department of Agriculture (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.

**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 3-12. The table 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, 2019e).

### 3.6.2 Aquatic Resources

**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.

**Aquatic Biota**

**Fisheries survey data**

The MPCA has conducted fisheries surveys on several streams and rivers in the Project area.

Birch Lake Reservoir

Birch Lake reservoir 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 reservoir from 1981 through 2015. Fish species reported by the

MDNR for Birch Lake reservoir 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 reservoir, 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, in part due to its larger appetite compared to native species of crayfish.

<u>Keeley Creek</u>

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).

<u>Stony River</u>

Stony River was sampled by the MPCA in 2014 upstream of where the transmission corridor would cross at station ID 14RN007. Aquatic biota sampling conducted in Stony River documented the presence of eight fish species and dominated by burbot. 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).

<u>Denley Creek</u>

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. Aquatic biota sampling conducted in Denley Creek documented the presence of 11 fish species and dominated by northern redbelly dace (MPCA, 2014c). In addition, MPCA documented a diverse invertebrate community. 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 reservoir. 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 (two birds, six fish, six insects, one mussel, one reptile and 16 vascular plants). Potential sensitive aquatic species within the Project area are identified in Table 3-13. The table 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, 2019e).

**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 reservoir 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 reservoir and other in the vicinity of the Project area since 2009.

Wild rice as a cultural resource is discussed in Section 3.7.3.

## 3.7 Historic Properties and Cultural Resources

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 3-14 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;
- A Phase I archaeological survey for hydrogeologic field activities was conducted in 2012. No archaeological resources were identified;
- A Phase I survey of a portion of the Project area was completed 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;
- A Phase I survey was completed for proposed hydrogeologic and exploratory drilling activities in 2013. No archaeological resources were identified;
- In 2016, a Phase I survey associated with a potential access road route was completed. 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; and
- A Phase I survey of proposed hydrogeological well locations was completed in 2018, a portion of which were in the Project area. One previously identified archaeological site was encountered.

### 3.7.1 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.

### 3.7.2 Historic Properties

In addition to the two previously identified archaeological sites, two architectural properties have been previously inventoried within the Project area:

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.

### 3.7.3 Cultural Resources

Two potential cultural resources have been identified within the Project area during previous survey work or work associated with other projects. These two potential cultural resources 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.

The Chippewa people have a special cultural and spiritual tie to natural wild rice. Their migration story describes how they undertook a westward migration from eastern North America, which tribal prophets had foretold would continue until the Chippewa people found "the food that grows on water" (Benton-Banai, 1988). That food was wild rice, known as "manoomin," and it is revered to this day by the Chippewa as a special gift from the Creator. Natural wild rice remains a mainstay of traditional foods for the Chippewa community and offers significant nutritional value. The traditional practice of hand harvesting natural wild rice continues among both tribal and non-tribal cultures. As discussed in Section 3.6.2, the Project is located within the area that was ceded to the U.S. by Chippewa bands in 1854 and portions of the Project area associated with Birch Lake reservoir have been identified as a potential wild rice resource.

## 3.8 Socioeconomics and Environmental Justice of the Local Community

A memorandum addressing current socioeconomic data, the *Twin Metals Minnesota - Socioeconomic Preliminary Baseline Demographic Data Collection*, was prepared for TMM by Short Elliott Hendrickson, Inc. (SEH) (SEH, 2018). A review of the current socioeconomic data was conducted for the Arrowhead region of northeastern Minnesota including Lake and St. Louis counties. Data sources include the 2010 U.S. Census (via the Bureau's American FactFinder), 2012 to 2016 American Community Survey data, Lake County and St. Louis County websites (including County Land Management Department webpages and Comprehensive Plans), Arrowhead Regional Development Commission plans, and the Northland Connection website.

Environmental Justice (EJ) refers to meeting the needs of underserved communities by reducing disparate environmental burdens, removing barriers to participation in decision making, and increasing access to environmental benefits that help make all communities safe, vibrant, and healthy places to live and work. In 1994, Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations* set forth the responsibility of Federal agencies to "make achieving environmental justice part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands."

According to Federal Highway Administration direction on conducting EJ analysis, a minority community is generally defined as one where the minority population in a study area (census tract or block group) is: either 10% higher than the county average; greater than 50% of the total geographic unit; or determined based on input from local officials or stakeholders. Determining the presence of low-income persons, groups, or clusters (e.g., living in geographic proximity) requires a review of the best available household income data and average household size compared to the U.S. Department of Health & Human Services (HHS) Poverty Guidelines. If the median household income of a "population" (census block, block group, or track) is determined to be below the HHS poverty guidelines, further investigations (field reviews, interviews, etc.) are needed to determine if an EJ population exists.

The presence or absence of EJ populations is addressed in the preliminary baseline data memorandum *Twin Metals Minnesota - Socioeconomic Preliminary Baseline Demographic Data Collection* (SEH, 2018).

## 3.9 Visual Resources

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 reservoir. Birch Lake reservoir 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).

## 3.10 Climate

The climate of the Project area is considered continental. The Project area, and the state of Minnesota as a whole, experiences continental polar air masses throughout the year with frequent outbreaks of arctic air masses pushing south during the winter months. During the summer months, warm and moist air masses often move north from the Gulf of Mexico, especially into the southern part of the state. When a more zonal air flow sets up, Pacific air masses moving across the country from west to east result in relatively mild and dry conditions (NCDC, 2019).

Prevailing wind directions, based on data from Hibbing, Minnesota (Station #94931) (Figure 3-28), 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).The 30-year normal data from the Ely, Minnesota airport (reported as Babbitt, Minnesota in the dataset) indicates a mean annual temperature of 36.9 degrees (°) Fahrenheit (F) (2.72° Celsius [C]) with monthly mean temperatures ranging from -8.4°F to 77.5°F (-22.4°C to 25.3°C). The coldest month is January with an average low temperature of -8.4 °F (-8 °C) and the warmest month is July with an average high temperature of 77.5 °F (26 °C).

The dataset from the Ely, Minnesota airport indicates that peak precipitation occurs during the months of May through September and ranges from 3.7 to 4.2 inches (7.62 to 10.7 cm) per month and an annual total of 30.2 inches (76.6 cm).

Storm events used for Project facility design include:

- 100-year, 24-hour storm event = 5.5 inches (140.7 mm);
- 10-year, 24-hour storm event = 3.5 inches (88.4 mm); and
- 100-year snow pack melt of 36 to 73 inches producing 10.9 inches (276.8 mm) water equivalent.

## 3.11 Air

### 3.11.1 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-hour, 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 3-15.

### 3.11.2 Air Quality Standards

Through the federal Clean Air Act (CAA), under Title 42 U.S. Code Section 7401 et seq, the U.S. Environmental Protection Agency (USEPA) has developed National Ambient Air Quality Standards (NAAQS), under Title 40 CFR 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.

### 3.11.3 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.

## 3.12 Noise

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.

### 3.12.1 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 3-29 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 through 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 3-16 and indicate times that are very quiet (<20 A-weighted decibel [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.

### 3.12.2 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 reservoir), camping to the north, west, and southwest, and a resort (across Birch Lake reservoir to the northwest) (Figure 3-30).

### 3.12.3 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 Minnesota Rules, part 7030.0040.

Additionally, 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.

## 3.13 Transportation

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 CR 21 / CR 120, New Tomahawk Road, NFR 1900, and NFR 1901 shown on Figure 3-31. NFR 1436 and 1493 are secondary access roads and were therefore not considered in the baseline.

### 3.13.1 Traffic Conditions

The following are baseline traffic conditions for roadways which would be impacted by the Project.

**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.

**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.

### 3.13.2 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 3-17.

#### 3.13.3 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.

# 4.0 ENVIRONMENTAL PROTECTION MEASURES

## 4.1 General Considerations, Commitments, and Design Criteria

While many environmental protection measures can be categorized as operational, the following general considerations, commitments, and design criteria have been applied to the Project for the purpose of protecting environmental resources from the planning and design stage. The environmental protection measures listed below are generally also included in the following resource-specific sections:

- The Project has been designed as an underground mine to reduce surface disturbance, noise, fugitive dust, light emissions, visual, and surface water-related impacts;
- No mining would occur under Birch Lake reservoir;
- 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 lined dry stack facility has been selected as a tailings disposal method to reduce ground disturbance, wetland impacts, water appropriation requirements, and the potential for seepage. Additionally, a lined dry stack facility has been selected because it would be highly geotechnically stable;

- After Project closure, no permanent infrastructure, with the exception of the lined dry stack facility and some non-contact water management features, would remain.
- To protect water resources:
  - The potential for run-on would be minimized through implementation of diversion dikes and non-contact water ditches described in Appendix C.
  - The process water pond would be double lined with leak detection as described in 2.13.3;
  - All contact water ponds would be single lined as discussed in Section 2.13.3;
  - contact water ponds would be sized to contain the 100-year, 24-hour storm event. In addition, the collective storage capacity of the contact water ponds for the lined dry stack facility would be sized to meet the stormwater runoff requirements from a 100-year snowpack;
  - The dry stack facility would be lined as described in Section 2.5.5;
  - The dry stack facility would include an under-liner drainage system to protect groundwater resources if seepage occurs as described in Section 2.5.5;
  - 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;
  - A cover would be placed on the lined dry stack facility. The cover at closure is anticipated to consist of at least two feet of cover soil underlain by a hydraulic barrier;
  - A grout curtain would be installed during construction of the lined dry stack facility to protect water resources in the event the dry stack facility produces seepage;
  - The lined dry stack facility design avoids direct impacts to Keeley Creek through the implementation of ponds, ditches, and water conveyances and sited 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 determined to be 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 minimize potential impacts to wetlands through avoidance; and
  - The lined 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 reduce impacts to known cultural resources.
- 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 coarse 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 negative pressure 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 coarse 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 lined dry stack facility would be concurrently reclaimed, whereby construction and revegetation would be sequenced to minimize potential effects to the view from Birch Lake reservoir;
  - Building colors would be selected to blend into the surrounding environment; and
  - Steps would be taken to limit light pollution consistent with the Dark Sky Initiative (IDA, 2019).
- To reduce impacts related to surface disturbance:

  - The underground workings would be backfilled with waste rock and engineered tailings backfill to reduce surface disturbance;
  - Ventilation raises would be located on or near existing USFS and exploration drill roads to reduce surface disturbance from new roads;
  - Exhaust ventilation fans would be located underground;
  - Power for the surface ventilation raises would be brought up from the underground mine 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.

## 4.2 Water Resources

### 4.2.1 General Water Management

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 through reuse during processing. To reduce potential impacts to water quality, water at the Project would be managed in three different ways to reduce the potential for significant effects to receiving waters.

Contact and process water would consist of any water which has come into contact with ore, tailings, or any portion of the Project operations. This includes process water (i.e. industrial wastewater), seepage (if any), mine inflow water, and tailings runoff. Contact and process water would be routed to contact water ponds, then recycled for use as process water.

Non-contact water would consist of stormwater runoff which has not come into contact with Project operations and is captured in stormwater collection systems. This includes meteoric water, runoff from undisturbed portions or reclaimed portions of the Project area, and stormwater intercepted before contacting contact water. The general approach in managing non-contact stormwater is: to prevent external, non-contact stormwater from mixing with and therefore becoming contact water; to minimize scour and erosion potential; and to minimize total suspended solids and other constituents prior to discharge to surface water.

Domestic, sewage, and sanitary waste waters 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.

Additionally, during Project construction, potential impacts to surface water quality would be reduced as described in Section 2.16.15. TMM has prepared a non-contact water management plan and a contact and process water management plan

(Appendix C and Appendix D, respectively). These plans identify more specific control measures for the Project.

### 4.2.2 Facility-Specific Water Management

The temporary rock storage facility, dry stack facility, and contact water ponds would be single lined with a geomembrane liner. The process water pond would be double lined with HDPE or an engineer-approved alternate geomembrane liner and constructed with a leak detection system to prevent seepage of contact and process water into the groundwater. Process facilities, fuel and reagent storage areas, and hazardous and solid waste storage areas would be constructed with appropriate containment as described in the spill contingency plan (Appendix F).

No waste rock would be permanently stored on the surface thereby negating the need to construct waste rock facilities and reducing potential impacts to water quality related to geochemistry. Process facilities have been designed to minimize surface disturbance, thereby reducing potential impacts to water quality related to erosion. BMPs would be utilized to minimize surface disturbance and erosion potential. These are discussed further in Section 4.10.

Monitoring for surface water and groundwater would be carried out in accordance with a Project monitoring plan. Surface water quality and quantity would be monitored in accordance with applicable permits and would include sampling at upstream and downstream off-site locations. Following are the types of monitoring proposed:

- Background monitoring - Background water quality and surface flow monitoring would be conducted to document surface water quality and quantity upstream of potential Project impacts; and
- Monitor-only – At these types of stations, no limits or standards would apply. However, there may be triggers which could initiate further investigation. These sampling locations for water quality and surface flow would be located downstream of potential Project impacts.

Groundwater monitor wells would be established at the Project, and groundwater quality and groundwater levels (to assess groundwater gradients or changes in groundwater gradients) would be monitored according to permit requirements. Groundwater monitoring data and field observations would be collected and reviewed for the following:

- Compliance monitoring – This would be performed at locations where the Project is required to demonstrate compliance with applicable permit limits. Locations are downgradient of potential Project impacts, typically at or near property boundaries;

- Indicator monitoring – This type of monitoring would be conducted at locations between Project features and the compliance monitoring stations to allow for early detection of potential Project impacts;
- Performance monitoring – This type of monitoring would be performed to assess the performance of engineering infrastructure (e.g., liner systems, containment systems). Performance monitoring stations would include monitoring wells, paired monitoring wells, and paired piezometers; and
- Background monitoring – This type of monitoring would be performed to document groundwater quality upgradient of the Project.

## 4.3 Air Quality

Process facilities have been designed using a compact layout with underground crushers and enclosed materials handling sites to reduce potential impacts to air quality. Appropriate air quality permits would be obtained from the MPCA for Project facilities and land disturbance. As per MPCA regulations, the Project air quality operating permit must be authorized prior to Project construction.

Air quality practices would include, but may not be limited to, the following:

- A water spray system would be installed at crushers and transfer conveyor areas, and transfer points would be hooded or covered, as determined to be necessary;
- Engineered control equipment would be used (e.g., wet scrubbers, dust collectors, etc.) at process areas requiring dust and/or emission controls, as determined to be necessary;
- Equipment and machinery would be maintained in good working condition to minimize emissions;
- Air velocity would be kept at an optimal level to reduce dust generation from conveyance systems;
- Posted speed limits would be adhered to on Project roads;
- Water would be applied to roads and other disturbed areas to reduce fugitive dust emissions. A chemical dust suppressant application (such as Lignin sulfate or magnesium chloride, or similar product) may be used where appropriate;
- Disturbed areas would be seeded with an interim seed mix to minimize fugitive dust emissions from un-vegetated surfaces, where appropriate;
- Personnel would be bussed from the administration building in Babbitt and the parking lot in Ely to the Project to reduce vehicle emissions; and
- Complete combustion of blasting materials would be ensured through proper blast design protocols.

## 4.4 Visual Resources and Lighting

The Project has been designed to reduce potential impacts to visual resources as practicable. Visual resource environmental protection measures would include:

- The comminution circuit and the flotation circuit have been designed to reduce the height of the concentrator building;
- The coarse ore stockpile has been designed to minimize the height of its geodesic dome cover;
- Permanent crushers would be located underground and the materials handling sites would be enclosed to reduce potential visual impacts related to dust; and
- Revegetation of the lined dry stack facility would be designed to be ongoing during operations beginning with the face closest to Birch Lake reservoir.

In addition, TMM would apply the following visual resource protection measures throughout the life of the Project:

- TMM would apply lighting mitigation measures that follow the Dark Sky Initiative (IDA, 2019) lighting practices. Specifically, light fixtures would incorporate shields and/or louvers where possible and be full cut-off type;
- Project lighting, where practicable, would be located to avoid light pollution onto adjacent land as viewed from a distance. Light fixtures would be placed at the lowest practical height, would be directed downward, and directed onto operating areas, as necessary;
- The use of dimmers, timers, and motion sensors would be installed where appropriate;
- Buildings would be painted, stained, and/or treated to produce flat-toned, non-reflective surfaces. Facilities would be painted using agency-approved color chart colors, where applicable; and
- Fugitive dust would be minimized in order to reduce “sky glow,” by reducing the light reflectance from dust particles.

## 4.5 Public Access and Recreation

Public safety would be maintained throughout the life of the Project. To protect public safety, activities would be conducted in conformance with applicable local, state, and federal health and safety requirements. Project visitors would be properly instructed in site safety procedures prior to admittance. TMM would install perimeter fencing and restrict access to the public during operations and appropriate signage would be conspicuously displayed.

## 4.6 Cultural and Archaeological Resources

The Project has been designed to minimize surface disturbance, thus minimizing potential impacts to cultural and archaeological resources.

Avoidance is the preferred treatment for preventing adverse effects to unevaluated cultural resources and prehistoric or historic sites eligible for listing in the National Register of Historic Places. If avoidance is not feasible, because an area is needed for mine facilities or Project operations, or if avoidance is not adequate to prevent adverse effects, TMM would undertake mitigation such as data recovery at the affected historic properties in accordance with the applicable Programmatic Agreement or Memorandum of Agreement between BLM, Minnesota Historic Preservation Office, and the Advisory Council on Historic Preservation. Development of a treatment plan, data recovery, archaeological and architectural documentation, and report preparation would be based on the "Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation," 48 FR 44716 (September 29, 1983), as amended and annotated, and other guidelines, as appropriate. If an unevaluated site cannot be avoided, additional information would be gathered and the site would be evaluated, as applicable. If the site does not meet eligibility criteria as defined by the National Register Criteria for Evaluation, and/or if the site is determined to have no cultural significance, in particular those identified by Native American tribes, no further cultural work would be performed. If the site meets the eligibility criteria or is determined to have cultural significance, a data recovery plan or appropriate mitigation would be completed under an applicable Programmatic Agreement or Memorandum of Agreement.

To minimize the potential for illegal collection, vandalism, and inadvertent damage, TMM would ensure that its Project personnel and contractors are instructed on cultural resource avoidance and protection measures, including the statutes protecting cultural resources as part of its environmental training program prior to being authorized to work in the Project area.

TMM employees would be trained to identify cultural resources. Training would be administered to new hires and as an annual refresher to current TMM employees using agency-approved materials. If cultural resources are encountered during Project construction, operation, or reclamation, activity in the area of the discovery would cease immediately. The agency Authorized Officer (AO) would be notified and the resource would be evaluated. The results of the evaluation would determine subsequent action.

If construction or other Project personnel discover what may be human remains, funerary objects, or items of cultural patrimony on federally administered public land, construction would cease within the vicinity of the discovery and the county coroner or sheriff would be notified of the find. The location of the find would not be publicly disclosed, and the remains would be secured and preserved in place. TMM or its contractors would immediately notify the agency AO of the discovery, followed by written notification. Discovered Native American human remains, funerary objects, or items of cultural patrimony found on federally administered public land would be handled in accordance with the Native American Graves Protection and Repatriation Act. Non-Native American human remains would be handled as specified by the AO. Construction would not resume in the area of the discovery until the agency AO has issued a Notice to Proceed.

If any human remains or associated funerary objects are discovered during construction activities on private or non-federal public land, construction would cease within the vicinity of the discovery and the county coroner or sheriff would be notified of the find. The location of the find would not be publicly disclosed, and the remains would be secured and preserved in place. Treatment of discovered human remains (both Native American and non-Native American) and associated artifacts found on private or non-federal public land would be handled in accordance with Minnesota Statute 307.08.

## 4.7 Biological Resources

To minimize potential impacts related to biological resources resulting from surface disturbance, process facilities have been designed using a compact layout, with crushers located underground and enclosed materials handling sites. Additionally, the Project would use waste rock as backfill material. As such, permanent surface waste rock storage facilities would not be constructed.

Land clearing and surface disturbance activities would be avoided during the avian breeding season, as determined by the agencies, to comply with the Migratory Bird Treaty Act (MBTA) (16 U.S. Code 703-712, as amended). If surface disturbing activities are unavoidable during the avian breeding and nesting season, TMM would have a qualified-biologist survey the proposed disturbance areas for the presence of active nests immediately prior to the disturbance. If active nests are located, or if other evidence of nesting is observed (mating pairs, territorial defense, carrying nesting material, transporting of food), an appropriate buffer would be identified by the agencies, and the buffer would be placed around the nest to prevent destruction or disturbance of nests until the birds are no longer present. Breeding bird survey results would be valid for two weeks.

Operators would be trained to monitor the Project area for the presence of larger wildlife such as deer and sensitive species such as avian wildlife protected under the MBTA. Mortality information would be collected and reported on a quarterly basis in accordance with the MDNR. TMM would establish wildlife protection policies which would prohibit hunting, feeding, or harassment of wildlife.

Fencing would be installed around the tailings management site, plant site, and solution ponds as per guidance set forth by MDNR and USFS.

### 4.7.1 Threatened and Endangered and Special Status Species

Surveys for threatened, endangered, and special status wildlife and plant species would be conducted for the Project to gather information about general wildlife utilization of the area and the presence or absence of wildlife and plant species of concern. Depending on the survey results, TMM would work with the appropriate agencies to develop appropriate wildlife protection measures relevant for the species which may utilize the area.

### 4.7.2 Wetlands

TMM would conduct wetland and waterbody delineations for permitting and mitigation purposes including the identification of waters of the United States as defined by the CWA and 40 CFR § 230.3(s). The Project facility locations have been designed to avoid or minimize impacts to wetlands, and to avoid cross-slopes which may increase potential impacts to surface waters.

Any necessary requirements for wetland monitoring would be outlined in the Wetland Conservation Act approval and the CWA Section 404 wetland permit. Wetland monitoring would be designed to monitor direct and potential indirect impacts to wetlands at the Project. Monitoring would include assessing pre-project conditions, establishing hydrology monitoring locations in wetlands, conducting vegetation monitoring, conducting wetland boundary assessments, and comparing results to established impact criteria. Monitoring would assess whether Project activities have directly or indirectly impacted wetland areas. If monitoring identifies additional wetland impacts, provisions would be made to avoid, minimize, or restore wetland impacts, or to provide additional mitigation (Minn. R., § 8420.0520, subpart 6). More details on proposed monitoring requirements would be included in the Project's monitoring plan.

## 4.8 Subsidence

Initial modeling of subsidence using three-dimensional numerical simulations indicates 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), assuming average rock mass quality and no backfill (Wood, 2019).

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).

In the same assessment, 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."

To prevent subsidence, the project would operate with an appropriate crown pillar depth. Waste rock and engineered tailings backfill would provide confinement to the pillars and ensure long-term stability. More details on proposed monitoring requirements would be included in the Project's monitoring plan.

## 4.9 Noise

The Project would primarily be classified to be within noise area classification-1 as per Minnesota Administrative Rules Part 7030.0040. This classification would require a nighttime $L_{50}$ (50% of the time period of interest) of 50 dBA or less from the Project at sensitive receptors.

To minimize potential impacts to noise, the following design criteria would be implemented:

- The coarse ore stockpile and conveyors would be covered;
- The concentrator building would be contained within an insulated building. Major openings of the concentrator building would orient away from sensitive noise receptors;
- Insulated housing would be installed over the motors and radiators of the intake fans;
- Exhaust fans would be located underground;
- Permanent crushers would be located underground;
- After the completion of construction, blasting and ore extraction activities would occur underground;
- The ore handling system would utilize conveyors instead of trucks to transport ore to surface;
- Mobile equipment would be relocated as necessary to reduce noise emissions; and
- A berm may be constructed along the edge of the lined dry stack facility nearest sensitive receptors to deflect noise.
- Vibration from blasting activities would be subject to ongoing regulatory controls through the requirements of Minnesota Rules, part 6132.2900, subpart 2.

## 4.10 Erosion and Sediment Control

Construction stormwater management is discussed in Section 2.16.15. Construction stormwater BMPs would likely include:

- Erosion and sediment control structures such as diversions (e.g., runoff 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 stockpiles would be seeded as soon as practicable and safe. Concurrent reclamation of the lined dry stack facility would be maximized to the extent practicable to accelerate revegetation of disturbed areas. Sediment and erosion control measures would be routinely inspected, and maintenance/repairs performed, as needed.

Specific erosion and sediment control protection measures would include:

- The surfaces of the reclamation material stockpiles would be shaped after construction with overall slopes of 3 horizontal to 1 vertical to reduce erosion;
- To further minimize wind and water erosion, the reclamation material stockpiles would be seeded after shaping with an interim seed mix developed in conjunction with the USFS;
- Diversion channels and/or berms would be constructed around the reclamation material stockpiles as needed to prevent erosion from stormwater runoff;
- BMPs such as straw wattles or staked straw bales would be used at the Project area as necessary to contain sediment liberated from direct precipitation;
- The reclamation material stockpile sediment pond would be used to control sedimentation from stormwater;
- The surface of the lined dry stack facility would be constructed with overall slopes of 4H:1V for stability and to reduce erosion;
- A cover would be placed on the lined dry stack facility to support revegetation. The cover is anticipated to consist of at least two feet of cover soil underlain by a hydraulic barrier; and

- The lined dry stack facility would be concurrently reclaimed during Project operations.

Sediment and erosion control BMPs would be routinely inspected, evaluated for performance, and maintenance and repairs performed, as needed. Repairs would be performed and repairs and additional BMPs would be added as needed.

## 4.11 Materials and Waste Management

### 4.11.1 Sanitary and Solid Waste Disposal

Nonhazardous solid wastes generated at the Project would include waste paper, wood, scrap metal, and other domestic trash. These materials would be disposed of at a regulated, off-site landfill contracted by TMM.

As discussed in Section 2.15.2, sewage and sanitary liquid wastes would be collected and disposed off-site by a third-party, licensed contractor. Waste oil and lubricants would be collected and transported off-site by a buyer/contractor for recycling. Reagent containers would be recycled by the reagent supplier. Scrap metal would be sold to a dealer and transported off-site.

Nonhazardous solid wastes from the laboratory would be disposed of in an off-site landfill. Other wastes from the laboratory exhibiting hazardous characteristics, including off-specification commercial chemicals, would be managed as hazardous waste.

Employee training would include appropriate disposal practices such as identifying allowable wastes that can be shipped to a landfill, management of used filters, oily rags, fluorescent light bulbs, aerosol cans, and other regulated substances. Used solvent, liquids drained from aerosol cans, accumulations of mercury fluorescent lights, and used antifreeze may be regulated pursuant to RCRA.

### 4.11.2 Hazardous Materials Management

The term “hazardous materials” is defined in 49 CFR § 172.101. Hazardous substances are defined in 40 CFR § 302.4 and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) Title III. Hazardous materials would be transported to the Project by U.S. DOT regulated transporters and stored on-site in U.S. DOT approved containers. Spill containment structures would be provided for storage containers. Hazardous materials would be managed in accordance with regulations identified in 40 CFR § 262 Standards Applicable to Generators of Hazardous Waste.

Hazardous materials and substances that may be transported, stored, and used at the Project in quantities less than the Threshold Planning Quantity designated by

SARA Title III for emergency planning include blasting components, petroleum products, and small quantities of solvents for laboratory use. Small quantities of hazardous materials not included in the above list may also be managed at the Project; such materials may include commercially produced paints, office products, and automotive maintenance products.

Blasting components would be stored on-site as specified in Section 2.3.7 and Section 2.4.7. Explosive materials would be stored in compliance with applicable federal, state, and local requirements.

Management of hazardous materials at the Project would comply with applicable federal, state, and local requirements, including the inventorying and reporting requirements of Title III of CERCLA, also known as the Emergency Planning and Community Right to Know Act.

Liquid petroleum products and reagents used in the process would be stored in above-ground tanks within a secondary containment area capable of holding 110% of the volume of the largest vessel in a given containment area, per 40 CFR § 267.197.

Fuel and oil for diesel and gas-powered equipment would be stored in above-ground, covered tanks. The tanks would include appropriate secondary containment, as required by state regulation. The refueling hoses would be equipped with overflow prevention devices as well as secondary containment.

Hazardous wastes would be managed in a short-term storage facility within the concentrator building prior to shipment to an off-site licensed disposal facility. These materials may include laboratory waste, waste paints, and thinners. Spent solvents and used oils would be returned to recycling facilities. Waste oil and lubricants would be collected and hauled off-site by a buyer/contractor for recycling. Solvents would be collected by a subcontractor and disposed of or recycled off-site.

A spill contingency plan addressing the handling and containment of hazardous materials anticipated to be used at the Project is presented in Appendix F. The spill contingency plan would be reviewed and updated regularly and when major material management changes are made.

### 4.11.3 Petroleum Contaminated Soils

Petroleum contaminated soils resulting from spills or leaks of hydrocarbons would be addressed immediately in accordance with the Project's spill contingency plan (Appendix F) and removed from the spill site and stored on the temporary rock storage facility or on an appropriate secondary containment area in accordance with applicable federal and state guidelines prior to disposal. Petroleum contaminated soils would be shipped to an off-site facility for disposal in accordance with RCRA regulations.

## 4.12 Protection of Survey Monuments

If they exist, TMM would protect survey monuments, witness corners, reference monuments, bearing trees, and line trees against unnecessary or undue destruction or damage. If, in the course of operations, monuments, corners, or accessories are destroyed, TMM would immediately report the matter to the AO. Prior to destruction or damage during surface disturbing activities, TMM would contact the USFS.

## 4.13 Fire Management and Protection Procedures

As specified by MSHA, TMM would institute a fire protection training program and would have a rehearsed fire suppression plan. A fire protection system would be installed that would incorporate county and/or state code requirements in the mine services building, concentrator building, and concentrator services building. As required by state and county regulations, water would be reserved for fire protection, as discussed in Section 2.13.3, and would be serviced by dedicated firewater protection pumps and hydrants. Sprinklers systems would be installed as required. On the surface, water trucks used for dust suppression would be available in the event of a fire.

TMM would promptly comply with county, state, and federal emergency directives and requirements pertaining to industrial operations during the fire season.

The following precautionary measures would be taken to prevent wildland fires:

- Light vehicles would be fitted with spark arrestors and would carry firefighting equipment, as required by regulation;
- Vehicle catalytic converters would be inspected often and cleaned of brush and grass debris;
- Vegetation would be periodically cleared from around the transmission line;
- Welding operations would be conducted in an area free of vegetation. A minimum of 10 gal of water (38 liter [L]) and a shovel would be on hand to extinguish spark-related fires. Extra personnel would be at the welding site to watch for fires created by welding sparks;
- Wildland fires would be reported immediately to emergency response personnel by calling 9-1-1. Subsequent reporting would be provided to the MDNR and the Minnesota Interagency Fire Center;
- To the extent known by TMM, the information provided would include the location (latitude and longitude if possible), what is burning, the time the fire started, who/what is near the fire, and the direction of fire spread; and
- TMM would contact the MDNR to find out about fire restrictions in place and to advise this office of approximate beginning and ending dates for exploration activities outside of the Project area.

Because the coarse ore stockpile reclaim tunnel is an enclosed area, sprinklers are required. As this area is exposed to the outside air temperature, a dry sprinkler system would be installed to prevent the lines from freezing.

### 4.14 Noxious Weeds and Invasive Exotic Species

TMM recognizes the economic and environmental impact that can result from the establishment of noxious weeds and has committed to a proactive approach to weed control. A noxious weed survey would be completed prior to earth moving disturbances. Areas of concern for noxious weeds would be flagged by a weed scientist or qualified biologist to alert personnel to avoid those areas, as practicable. Information and training regarding noxious weeds management and identification would be provided to personnel affiliated with Project implementation and maintenance.

In general, vehicle and heavy equipment which may have been exposed to noxious weeds would be cleaned with a power or high-pressure washer prior to entering or leaving the Project area. Vehicle cleaning would eliminate the transport of vehicle-borne weed seed, roots, or rhizomes. To eliminate the transport of soil-borne noxious weed seeds, soils infested with roots or rhizomes would be stockpiled adjacent to the areas from which they were stripped. Appropriate measures would be taken to avoid wind or water erosion of the affected stockpile. Interim and final seed mixes, hay, straw, and hay/straw products would be certified weed-free from Minnesota and USFS-identified noxious weeds.

Weed monitoring would be conducted for the life of the operation or until the site is released and the reclamation financial surety is released. If the spread of noxious weeds is noted, weed control procedures would be determined in consultation with USFS personnel and would be in compliance with USFS handbooks and applicable laws and regulations.

Mixing of herbicides and rinsing of herbicide containers and spray equipment would be conducted only in areas that are a specified distance from environmentally sensitive areas and points of entry to bodies of water (storm drains, irrigation ditches, streams, lakes, or wells).

# 5.0 OPERATING PLANS

### 5.1 Non-Contact Water Management Plan

The non-contact water management plan is included in Appendix C.

### 5.2 Contact and Process Water Management Plan

The contact and process water management plan are included in Appendix D.

## 5.3 Rock Characterization and Handling Plan

TMM is currently undertaking a waste characterization program in consultation with the MDNR to support the Project. The results from TMM's waste characterization program would be used to define a rock characterization and handling plan for the Project.

Minnesota Rules, § 6132.1000 and 6132.2200 require geochemical characterization of "mine wastes" from nonferrous mining projects to support the Project's scoping and permitting process. Mine waste is defined broadly by Minnesota Rules § 6132.0100, subpart 16 to mean a "material, such as surface overburden, rock, lean ore, leached ore, or tailings that in the process of mining and beneficiation has been exposed or removed from the earth."

Geochemical characterization is a method for evaluating the reactivity of rock, minerals, and the potential for generation of ARD and metal leaching (ML). ARD is a result of the natural oxidation of sulfide minerals when exposed to air and water. The process of oxidation occurs in series of chemical reactions and in stages, which typically progress from a near neutral state to a more acidic state. The rate at which this reaction occurs can vary based on a number of different environmental factors such as mineral content and climate. 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 patterns. Analysis of these weathering patterns 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 the following fundamental understanding of the potential for ARD and ML:

- Sulfur content is the controlling factor for the rate and severity of ARD generation from Duluth Complex rocks.
- The silicate minerals (i.e., olivine and calcic plagioclase) present in Duluth Complex rocks are sufficient to maintain approximately non-acidic conditions for extended periods (i.e. decades) for rock with low total sulfur content. For higher total sulfur content rock, silicate minerals have the ability to neutralize the generation of acidity (i.e., neutralization potential) and delay the development of ARD, thereby allowing time for implementation of appropriate engineering controls.
- The potential for ARD is the primary control on ML.

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

- Characterization of sulfide mineralization and ARD and ML potential of tailings, waste rock, development rock, and ore associated with the Duluth Complex and GRB rock;
- Utilization of characterization data to further inform material management; and
- 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 composition and ARD analysis on development rock, waste rock, ore, and tailings. With respect to development rock and ore, less than 10% of samples tested to date are preliminarily classified as having an ARD potential. Unlike many other ore types, elevated sulfur contents in the Maturi deposit occur almost exclusively in association with the ore with the remainder of samples being classified as waste rock. Ore would be transported to surface and processed and the waste rock that has elevated sulfur, but below ore grade, would be placed in mined out stopes before engineered tailings backfill is pumped into the stope. Planned future testing of the development rock, waste rock, and ore includes continued static testing to inform necessary kinetic testing and additional mineralogical analysis with a specific focus towards the GRB that comprises the footwall, as this is a lesser studied rock unit.

Tailings samples included in the chemical composition and ARD 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. 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.

The development and implementation of the materials characterization program is an ongoing effort by TMM which would 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 development 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; and
- A summary of results broken into static testing, kinetic testing, and field testing.

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

TMM would manage Project waste rock, development rock, and ore to provide stable and safe storage in a manner which results in compliance with safety, mining, and environmental regulations.

## 5.4 Environmental Quality Assurance Plan

The environmental quality assurance plan is included Appendix G.

## 5.5 Spill Contingency Plan

The spill contingency plan is included as Appendix F.

## 5.6 Interim Management Plan

The interim management plan is included as Appendix H.

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# TABLES

Table 2-1: 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 |

Table 2-2: Requirements for Leasable Minerals as per 43 Code of Federal Regulations § 3592

| Regulatory Requirement as per 43 CFR § 3592 | Specifications Applicable to a Mine Plan of Operations | Location in Document |
|---|---|---|
| .1(c)(1) | Names, addresses and telephone numbers of those responsible for operations to be conducted under the approved plan to whom notices and orders are to be delivered, names and addresses of lessees, Federal lease serial numbers and names and addresses of surface and mineral owners of record, if other than the United States. | Section 1.0 – Operator Information<br><br>Appendix A – Mineral and Surface Ownership Information |
| .1(c)(2) | A general description of geologic conditions and mineral resources, with appropriate maps, within the area where mining is to be conducted. | Section 3.2 – Geology and Minerals |
| .1(c)(3) | A copy of a suitable map or aerial photograph showing the topography, the area covered by the lease(s), the name and location of major topographic and cultural features and the drainage plan away from the affected area. | Topography of the Project area is illustrated in Figure 3-13.<br>The area covered by the leases is illustrated in Appendix A – Mineral and Surface Ownership Information.<br>Cultural features are discussed in Section 3.8, and maps identifying cultural resources can be requested from the MDNR or the BLM.<br>Drainage plans for the Project area are included in Appendix C. |

| Regulatory Requirement as per 43 CFR § 3592 | Specifications Applicable to a Mine Plan of Operations | Location in Document |
|---|---|---|
| .1(c)(4) | A statement of proposed methods, of operating, including a description of the surface or underground mining methods, the proposed roads, the size and location of structures and facilities to be built, mining sequence, production rate, estimated recovery factors, stripping ratios, and number of acres in the Federal or Indian lease(s), license(s), or permit(s) to be affected. | A description of proposed operations is included in Section 2.0 – Description of Operations<br><br>As an underground mine, there would be no stripping.<br><br>Mining sequence and production rates are identified in Figure 2-18 through Figure 2-22, Table 2-11, and Table 2-12.<br><br>Estimated recovery factors are discussed in Section 2.3.<br><br>Acres of federal leases affected by the Project are identified in Appendix A – Mineral and Surface Ownership Information. Acres of federal leases affected by the Project identified in Appendix A do not reflect planned surface disturbance. |
| .1(c)(5) | An estimate of the quantity and quality of the mineral resources, proposed cutoff grade and, if applicable, proposed blending procedures for all leases covered by the mining plan. | An estimate of the quantity and quality of the mineral resources over the 25-year active mine life by production and resource category are included Table 2-11 and Table 2-12.<br><br>The proposed cutoff grade is discussed in Section 2.3. There are no proposed blending procedures. |

| Regulatory Requirement as per 43 CFR § 3592 | Specifications Applicable to a Mine Plan of Operations | Location in Document |
|---|---|---|
| .1(c)(6) | An explanation of how ultimate maximum recovery of the resource will be achieved for the Federal or Indian lease(s). If a mineral deposit, or portion thereof, is not to be mined or is to be rendered un-minable by the operation, the operator/lessee shall submit appropriate justification to the authorized officer for approval. | Section 2.3 |
| .1(c)(7) | Appropriate maps and cross sections showing: | |
| .1(c)(7)(i) | Federal or Indian lease boundaries and serial numbers. | Appendix A – Mineral and Surface Ownership Information |
| .1(c)(7)(ii) | Surface ownership and boundaries. | Appendix A – Mineral and Surface Ownership Information |
| .1(c)(7)(iii) | Locations of existing and abandoned mines. | Figure 2-1 |
| .1(c)(7)(iv) | Typical structure cross sections. | Figure 2-4, Figure 2-6, Figure 2-8, Figure 2-9, Figure 2-10, Figure 2-13, Figure 2-14, Figure 2-15; Figure 2-17, and Figure 2-23 |
| .1(c)(7)(v) | Location of shafts or mining entries, strip pits, waste dumps, and surface facilities. | Figure 2-2, Figure 2-5, Figure 2-11, and Figure 2-16 |
| .1(c)(7)(vi) | Typical mining sequence, with appropriate timeframes. | Mining sequence over the 25-year mine life is identified in Figure 2-18 through Figure 2-22, Table 2-11, and Table 2-12 |
| .1(c)(8) | A narrative which addresses the environmental aspects associated with the proposed mine which includes, at a minimum, the following: | Section 3.0 – Environmental Setting |
| .1(c)(8)(i) | An estimate of the quantity of water to be used and pollutants that may enter any receiving waters. | This information will be provided in a *Hydrology Characterization Data Package, Volumes 1-3*. |
| .1(c)(8)(ii) | A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters. | Appendix D – Contact and Process Water Management Plan |

| Regulatory Requirement as per 43 CFR § 3592 | Specifications Applicable to a Mine Plan of Operations | Location in Document |
|---|---|---|
| .1(c)(8)(iii) | A description of measures to be taken to prevent or control fire, soil erosion, subsidence, pollution of surface and ground water, pollution of air, damage to fish or wildlife or other natural resources and hazards to public health and safety. | Chapter 4.0 – Environmental Protection Measures |
| .1(c)(9) | A reclamation schedule and the measures to be taken or surface reclamation of the Federal or Indian lease(s). license(s), or permit(s) that will ensure compliance with the established requirements. In those instances in which the lease requires the revegetation of an area affected by operations, the mining plan shall show: | Appendix B – Reclamation Plan |
| .1(c)(9)(i) | Proposed methods of preparation and fertilizing the soil prior to replanting. | Appendix B – Reclamation Plan |
| .1(c)(9)(ii) | Types and mixtures of shrubs, trees or tree seedlings, grasses or legumes to be planted. | Appendix B – Reclamation Plan |
| .1(c)(9)(iii) | Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees or tree seedlings, or combinations of grasses and trees. | Appendix B – Reclamation Plan |
| .1(c)(10) | The method of abandonment of operations on Federal or Indian lease(s), license(s), and permit(s) proposed to protect the unmined recoverable reserves and other resources, including the method proposed to fill in, fence or close all surface openings which are a hazard to people or animals. Abandonment of operations also is subject to the provisions of subpart 3595 of this title. | Appendix B – Reclamation Plan |

Table 2-3: 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 |

Table 2-4: Primary Mining Equipment

| Equipment | Count |
|---|---|
| Development Jumbo | 5 |
| Bolter | 9 |
| Loader 18 ton | 8 |
| Loader 14 ton | 15 |
| Haul Truck 30 ton | 5 |
| Haul Truck 40 ton | 14 |
| Easer | 1 |
| Uphole Production Drill | 1 |
| ITH Drill | 4 |
| Utility Cassette Carrier | 5 |

Table 2-5: Pre-operational Ore Stockpile Design Parameters and Dimensions Summary

| Facility | 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 |
|---|---|---|---|---|---|---|---|
| Pre-operational Ore Stockpile | 1.3H:1V (38°) | 1.8H:1V (29°) | 40 / 12 | 85 / 6 | 1,540 | 11.0 | 722,000 $yd^3$ / 1,213,000 short ton / 1,100,415 ton |

Table 2-6: Primary Fuels

| Fuel / Lubricant | Annual Consumption (L per year) | Storage ($m^3$) | Amount per Delivery (L / st) | Anticipated Trucks/Month | Approximate Consumption per Day (L per day) | Storage Time (days) |
|---|---|---|---|---|---|---|
| Diesel | 20,700,000 | 300 | 30,000 / 25 | 58 | 57,000 | 5 |
| Gasoline | 300,000 | 20 | 20,000 / 14.4 | 2 | 800 | 24 |
| Propane | 12,700,000 | 160 | 10 | 53 | 35,000 | 5 |

Table 2-7: Primary Reagents

| Reagent | Annual Consumption (short tons per year) | Transport Loads (short tons per delivery) | Deliveries per year (approximate) | Storage Capacity (short ton / type) |
|---|---|---|---|---|
| TETA (triethylenetetramine) | 650 | 19.6 | 34 | 25 / Bulk Solution |
| $Na_2SO_3$ (Sodium Sulphite) | 610 | 15.4 | 40 | 25 / Bags |
| Aerophine 3418A | 60 | 20.0 | 3 | 20 / Bulk Solution |
| SIPX | 1,400 | 15.4 | 91 | 25 / Bags |
| MIBC | 800 | 16.2 | 50 | 30 / Bulk Solution |
| Lime | 10,500 | 15.4 | 680 | 140 / Bulk |
| Copper Sulphate | 600 | 15.4 | 39 | 25 / Bags |
| Sulfuric Acid | 840 | 20.0 | 42 | 32 / Bulk Solution |
| Flocculant (Concentrate) | 3 | 15.4 | 8.0 | 5 / Bags |
| Flocculant (Tails) | 120 | with above | with above | with above |
| Binder (Slag-Cement Mix) | 34,000 | 15.4 | 2,210 | 450 / Bulk |

Table 2-8: Plant Site Reclamation Material Stockpiles Design Parameters and Dimensions Summary

| Facility | 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 |
|---|---|---|---|---|---|---|---|
| Reclamation Material Stockpile 1 | 50% | 33% | 23 / 7 | 31 / 9.4 | 1,532 | 2.2 | 65,430 $yd^3$ / 77,200 short tons / 70,035 tonne |
| Reclamation Material Stockpile 2 | 50% | 33% | 23 / 7 | 23t / 7 | 1,516 | 2.7 | 45,780 $yd^3$ / 54,020 short tons / 49,006 tonne |

Table 2-9: Surface Mobile Equipment

| Mobile Equipment | Number of Units |
|---|---|
| **Plant Site** | |
| 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 |
| **Tailings Management Site** | |
| 60 Ton Trucks | 12 |
| Front End Wheel Loader | 3 |
| Vibratory Roller Compactors | 3 |
| Dry Stack Facility Dozers | 3 |
| Graders | 2 |
| Water Trucks | 3 |
| Bob Cat | 2 |
| Fork Lift | 2 |
| Flat Bed Truck | 2 |
| Pickup Truck | 5 |

Table 2-10: Tailings Management Site Reclamation Material Stockpile Design Parameters and Dimensions Summary

| Facility | Inter-Bench Slope* (Gradient) | Overall Slope (Gradient) | Lift Height (ft) | Max Height Above Original Topo (ft) | Crest Elevation (feet) | Surface Area (acres) | Volume ($yd^3$) |
|---|---|---|---|---|---|---|---|
| Tailings Management Site Reclamation Material Stockpile | N/A | 3H:1V | N/A | 50 | 1,534 | 16 | 871,000 |

3760 Table 2-11: Mine Plan Summary Based on Production

| Time | Stope (Mt) | % Copper | % Nickel | Cobalt ppm | Gold ppm | Lead ppm | Platinum ppm | Silver ppm |
|---|---|---|---|---|---|---|---|---|
| *Total* | *163.3* | -- | -- | -- | -- | -- | -- | -- |
| *Average* | -- | *0.69* | *0.22* | *110* | *0.10* | *0.44* | *0.19* | *2.51* |
| Year 1 | 5.54 | 0.76 | 0.24 | 130 | 0.09 | 0.33 | 0.14 | 2.72 |
| Year 2 | 6.62 | 0.81 | 0.26 | 130 | 0.09 | 0.36 | 0.15 | 2.90 |
| Year 3 | 6.62 | 0.78 | 0.25 | 130 | 0.09 | 0.33 | 0.14 | 2.74 |
| Year 4 | 6.57 | 0.73 | 0.24 | 130 | 0.08 | 0.32 | 0.14 | 2.59 |
| Year 5 | 6.54 | 0.73 | 0.24 | 120 | 0.09 | 0.33 | 0.14 | 2.58 |
| Year 6 | 6.61 | 0.75 | 0.24 | 120 | 0.09 | 0.33 | 0.14 | 2.63 |
| Year 7 | 6.58 | 0.72 | 0.24 | 120 | 0.08 | 0.32 | 0.14 | 2.51 |
| Year 8 | 6.62 | 0.68 | 0.23 | 120 | 0.08 | 0.33 | 0.14 | 2.41 |
| Year 9 | 6.62 | 0.70 | 0.24 | 110 | 0.10 | 0.39 | 0.18 | 2.54 |
| Year 10 | 6.62 | 0.71 | 0.24 | 110 | 0.10 | 0.39 | 0.17 | 2.61 |
| Year 11 | 6.62 | 0.72 | 0.24 | 110 | 0.10 | 0.42 | 0.19 | 2.61 |
| Year 12 | 6.62 | 0.70 | 0.24 | 110 | 0.10 | 0.39 | 0.18 | 2.52 |
| Year 13 | 6.62 | 0.70 | 0.24 | 110 | 0.10 | 0.42 | 0.19 | 2.54 |
| Year 14 | 6.62 | 0.72 | 0.23 | 110 | 0.10 | 0.46 | 0.20 | 2.69 |
| Year 15 | 6.61 | 0.69 | 0.22 | 100 | 0.11 | 0.49 | 0.21 | 2.59 |
| Year 16 | 6.53 | 0.68 | 0.21 | 100 | 0.12 | 0.52 | 0.22 | 2.51 |
| Year 17 | 6.51 | 0.68 | 0.20 | 100 | 0.14 | 0.64 | 0.28 | 2.56 |
| Year 18 | 6.58 | 0.65 | 0.19 | 90 | 0.13 | 0.62 | 0.27 | 2.46 |
| Year 19 | 6.56 | 0.66 | 0.19 | 90 | 0.13 | 0.61 | 0.27 | 2.53 |
| Year 20 | 6.62 | 0.61 | 0.18 | 90 | 0.12 | 0.55 | 0.24 | 2.29 |
| Year 21 | 6.62 | 0.57 | 0.16 | 90 | 0.11 | 0.51 | 0.23 | 2.11 |
| Year 22 | 6.58 | 0.65 | 0.20 | 100 | 0.11 | 0.50 | 0.22 | 2.40 |
| Year 23 | 6.62 | 0.66 | 0.20 | 100 | 0.11 | 0.50 | 0.23 | 2.41 |
| Year 24 | 6.44 | 0.64 | 0.20 | 100 | 0.11 | 0.48 | 0.22 | 2.29 |
| Year 25 | 6.22 | 0.60 | 0.19 | 100 | 0.10 | 0.45 | 0.20 | 2.15 |

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Table 2-12: Mine Plan Summary Based on Resource Category

| Mineral Leases (Stopes) | | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Federal (Mt)** | **State (Mt)** | **Private (Mt)** | **Federal (%)** | **State (%)** | **Private (%)** |
| *Total* | *99.9* | *58.2* | *5.2* | -- | -- | -- |
| *Average* | -- | -- | -- | *61* | *36* | *3* |
| Year 1 | 5.54 | 0.00 | 0.00 | 100 | 0 | 0 |
| Year 2 | 6.62 | 0.00 | 0.00 | 100 | 0 | 0 |
| Year 3 | 6.36 | 0.26 | 0.00 | 96 | 4 | 0 |
| Year 4 | 6.31 | 0.27 | 0.00 | 96 | 4 | 0 |
| Year 5 | 5.92 | 0.62 | 0.00 | 90 | 10 | 0 |
| Year 6 | 5.90 | 0.71 | 0.00 | 89 | 11 | 0 |
| Year 7 | 5.65 | 0.92 | 0.01 | 86 | 14 | 0 |
| Year 8 | 5.82 | 0.70 | 0.10 | 88 | 11 | 2 |
| Year 9 | 4.67 | 1.79 | 0.16 | 70 | 27 | 2 |
| Year 10 | 4.12 | 2.45 | 0.05 | 62 | 37 | 1 |
| Year 11 | 3.64 | 2.83 | 0.16 | 55 | 43 | 2 |
| Year 12 | 2.65 | 3.82 | 0.14 | 40 | 58 | 2 |
| Year 13 | 3.20 | 3.01 | 0.41 | 48 | 46 | 6 |
| Year 14 | 4.40 | 0.94 | 1.29 | 66 | 14 | 19 |
| Year 15 | 4.86 | 1.28 | 0.47 | 74 | 19 | 7 |
| Year 16 | 4.65 | 1.76 | 0.12 | 71 | 27 | 2 |
| Year 17 | 2.58 | 3.84 | 0.09 | 40 | 59 | 1 |
| Year 18 | 2.60 | 3.59 | 0.38 | 40 | 55 | 6 |
| Year 19 | 1.89 | 4.47 | 0.19 | 29 | 68 | 3 |
| Year 20 | 2.30 | 3.87 | 0.45 | 35 | 58 | 7 |
| Year 21 | 2.70 | 3.46 | 0.46 | 41 | 52 | 7 |
| Year 22 | 1.56 | 4.96 | 0.07 | 24 | 75 | 1 |
| Year 23 | 1.49 | 5.13 | 0.00 | 23 | 77 | 0 |
| Year 24 | 2.51 | 3.69 | 0.24 | 39 | 57 | 4 |
| Year 25 | 2.00 | 3.82 | 0.40 | 32 | 61 | 6 |

Table 2-13: Labor Profile

| Department | Payroll |
|---|---|
| General and Administrative | 62 |
| Underground Mine | 537 |
| Plant Site | 99 |
| Tailings Management Site | 67 |
| *TOTAL* | *765* |

Table 2-14: Contact Water Pond Dimensions

| Contact Water Pond | Catchment Area Size (acre / hectare) | Pond Volume (g / $m^3$) | Pond Footprint ($ft^2$ / $m^2$) | Average depth (ft / m) |
|---|---|---|---|---|
| Plant Site North contact water pond | 42.7 / 17.3 | 6,384,510 / 24,168 | 91,493 / 8,500 | 9.3 / 2.84 |
| Plant Site Central contact water pond | 41.5 / 16.8 | 23,470 | 97,144 / 9,025 | 8.5 / 2.60 |
| Plant Site South contact water pond | 42.7 / 17.3 | 6,384,510 / 24,168 | 94,453 / 8,775 | 9.0 / 2.75 |
| dry stack facility CWP1 | 252.3 / 102.1 | 66,021,087 / 249,917 | 711,247 / 66,077 | 13.9 / 4.25 |
| dry stack facility CWP2 | 47.0 / 19.0 | 7,938,106 / 30,049 | 75,207 / 6,987 | 13.1 / 4.00 |
| dry stack facility CWP3 | 98.8 / 40.0 | 12,447,259 / 47,118 | 110,890 / 10,302 | 20.0 / 6.10 |
| dry stack facility CWP4 | 79.3 / 32.1 | 11,290,978 / 42,741 | 266,784 / 24,785 | 5.9 / 1.80 |
| dry stack facility CWP5 | 115.4 / 46.7 | 14,118,940 / 53,446 | 368,535 / 34,238 | 5.9 / 1.80 |
| dry stack facility contact water pond.I1 | 35.3 / 14.3 | 4,787,854 / 18,124 | 70,966 / 6,593 | 5.2 / 1.60 |
| dry stack facility contact water pond.I2 | 41.5 / 16.8 | 12,056,284 / 45,638 | 174,354 / 16,198 | 9.2 / 2.80 |

768 Table 3-1: 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|
| F3D | Eveleth-Eagelsnest-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 |

| 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 |
|---|---|---|---|---|---|---|---|---|
| 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 |
| I2a31D | Eveleth-Eagelsnest-Conic complex, bouldery, 6 to 18 percent slopes, very rocky | 158 | No | moraines on till plains | Well drained | Moderate | High | Moderate |

| 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 |
|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|
| 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.

772 Table 3-2: 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 |

| Ecological Landtype Unit | Landtype Phase | Acres Within the Project Area[1] |
|---|---|---|
| 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 |
| 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 |

| Ecological Landtype Unit | Landtype Phase | Acres Within the Project Area[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 |
| **Site Units** | **Site Descriptions** | |
| BR | Bedrock | |
| GP | Gravel Pit | |
| INT | Intermittent Water Body | |
| LF | Landfill | |
| NM | Not Mapped | |
| Q | Quarry | |
| W | Water | |
| **Slope Qualifiers** | **Slope Descriptions** | |
| 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 | |

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

Table 3-3: Project Component Watersheds

| | 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 |
|---|---|---|---|---|---|---|---|---|---|
| Minnesota Department of Natural Resources Minor Watershed (acres) | | | | | | | | | |
| South Kawishiwi River | 3926.2 | 1735.5 | 152.9 | 121.4 | 111.0 | 62.3 | 7.5 | 14.9 | 43.6 |
| Keeley Creek | 1274.7 | | | 532.0 | 9.5 | 34.3 | | | |
| Filson Creek | 327.7 | 125.9 | | | | | | | |
| unknown | 317.6 | 125.1 | | | | | | | |
| Stony River | 260.4 | | | | 38.9 | | | | |
| Denley Creek | 180.6 | | | | 27.6 | | | | |
| U.S. Geological Survey HUC12 (acres) | | | | | | | | | |
| Birch Lake | 5200.9 | 1735.5 | 152.9 | 653.4 | 120.5 | 96.6 | 7.5 | 14.9 | 43.6 |
| South Kawishiwi River | 645.3 | 251.0 | | | | | | | |
| Outlet Stony River | 260.4 | | | | 38.9 | | | | |
| Denley Creek | 180.6 | | | | 27.6 | | | | |

Table 3-4: 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 3-5: 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 |

Table 3-6: Minnesota National Wetland Inventory Simplified Plant Community Classification Baseline

| Wetland Type | Baseline Acres[1] |
|---|---|
| Project area | |
| Coniferous Bog | 818.7 |
| Hardwood Wetland | 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 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.

Table 3-7: Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Baseline

| Wetland Type | Baseline Acres[1] |
|---|---|
| Project area | |
| Type 1 Seasonally flooded basins or flats | 3.9 |
| Type 2 Wet Meadows | 22.8 |
| Type 3 Shallow Marsh | 169.5 |

| Wetland Type | Baseline Acres[1] |
|---|---|
| Project area | |
| 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.

Table 3-8: U.S. Geological Survey GAP / LANDFIRE Data Baseline

| GAP Classification | Baseline Acres |
|---|---|
| Project area | |
| 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 |

Table 3-9: National Land Cover Data Baseline

| National Land Cover Data Classification | Baseline Acres |
|---|---|
| Project area | |
| 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 |

800 Table 3-10: Minnesota Department of Natural Resources Minnesota Biological Survey Data Baseline

| Type/Subtype Code | Type/Subtype Name Community total | S-Rank | Baseline Acres[1] |
|---|---|---|---|
| Project area | | | |
| 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* | | *807.3* |
| CTn32a | Mesic Mafic Cliff (Northern) | S3 | 2.0 |
| | *Cliff/Talus System Total* | | *2.0* |
| BW_CX | Beaver Wetland Complex | | 50.2 |
| | *Beaver Wetland Complex Total* | | *50.2* |
| MF_PDMW_CX | Poor Dry-Mesic Woodland_Mesic Forest Complex | | 469.8 |
| | *Mesic Woodland/Mesic Forest Complex Total* | | *469.8* |
| FDn32 | Northern Poor Dry-Mesic Mixed Woodland | | 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 | | 24.8 |
| FDn33a | Red Pine - White Pine Woodland | S3 | 65.1 |
| FDn43 | Northern Mesic Mixed Forest | | 4.0 |
| FDn43a | White Pine - Red Pine Forest | S2 | 116.5 |
| FDn43b1 | Aspen - Birch Forest, Balsam Fir Subtype | S5 | 122.2 |

| Type/Subtype Code | Type/Subtype Name Community total | S-Rank | Baseline Acres[1] |
|---|---|---|---|
| FDn43b2 | Aspen - Birch Forest, Hardwood Subtype | S5 | 4.0 |
| | *Fire-Dependent Forest/Woodland System Total* | | *1715.9* |
| FPn62a | Rich Black Spruce Swamp (Basin) | S3 | 70.2 |
| | *Forested Rich Peatland System Total* | | *70.2* |
| OPn81 | Northern Shrub Shore Fen | | 2.2 |
| OPn81b | Leatherleaf - Sweet Gale Shore Fen | S5 | 27.8 |
| OPn91 | Northern Rich Fen (Water Track) | | 4.8 |
| | *Open Rich Peatland System Total* | | *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* | | *29.0* |
| WMn82b1 | Sedge Meadow, Bluejoint Subtype | S5 | 41.4 |
| | *Wet Meadow/Carr System Total* | | *41.4* |
| | **Total** | | 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

807 Table 3-11: Terrestrial Vegetative 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 |
|---|---|---|---|---|---|---|---|
| Fungus | | | | | | | |
| Sarcosoma globosum | A Cup Fungus | none | special concern | | | Fire Dependent Forest | X |
| Lichen | | | | | | | |
| Ahtiana aurescens | Eastern candlewax lichen | none | special concern | | Yes | Forested Rich Peatland | X |
| Allocetraria oakesiana | Yellow ribbon lichen | none | threatened | Yes | | Fire Dependent Forest | X |
| Bryoria fuscescens | Pale-footed Horsehair Lichen | none | special concern | | | Fire Dependent Forest, Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Lobaria scrobiculata | Textured lungwort | none | endangered | Yes | | Forested Rich Peatland | X |
| Melanohalea subolivacea | Brown-eyed Camouflage Lichen | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Menegazzia terebrata | Port-hole Lichen | none | special concern | | | Forested Rich Peatland | X |
| Ochrolechia androgyna | Powdery Saucer Lichen | none | special concern | | | Fire Dependent Forest, Forested Rich Peatland | X |
| Peltigera venosa | Fan lichen | none | special concern | | | Fire Dependent Forest | X |
| Protopannaria pezizoides | Brown-gray Moss-shingle Lichen | none | threatened | Yes | | Forested Rich Peatland | X |
| Pseudocyphellaria holarctica | Yellow specklebelly lichen | none | endangered | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Ramalina thrausta | Angel's Hair Lichen | none | special concern | | | Forested Rich Peatland | X |
| Sticta fuliginosa | Peppered moon lichen | none | special concern | Yes | | Forested Rich Peatland | X |
| Thelocarpon epibolum | A Species of Thelocarpon Lichen | none | special concern | | | Fire Dependent Forest, Forested Rich Peatland | X |
| Usnea longissima | Methuselah's Beard Lichen | none | special concern | | | Fire Dependent Forest, Forest Acid Peatland, Forested Rich Peatland | X |
| Moss | | | | | | | |
| Buxbaumia aphylla | Bug-on-a-stick Moss | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest, Non-Forested Rich Peatland | X |
| Frullania selwyniana | Selwyn's Ear-leaf Liverwort | none | special concern | | | Forested Rich Peatland | X |

| 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 |
|---|---|---|---|---|---|---|---|
| Sphagnum compactum | Cushion Peat Moss | none | threatened | | | Fire Dependent Forest, Forest Acid Peatland | X |
| Splachnum rubrum | Red Parasol Moss | none | endangered | Yes | | Forest Acid Peatland, Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Vascular Plant | | | | | | | |
| Achillea alpina | Siberian Yarrow | none | threatened | | | Fire Dependent Forest | X |
| Botrychium lunaria | Common Moonwort | none | threatened | Yes | Yes | Fire Dependent Forest | X |
| Botrychium minganense | Mingan Moonwort | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Botrychium mormo | Goblin Fern | none | threatened | Yes | | Mesic Hardwood Forest | X |
| Botrychium oneidense | Blunt-lobed Grapefern | none | threatened | | Yes | Mesic Hardwood Forest | X |
| Botrychium pallidum | Pale Moonwort | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Botrychium rugulosum | St. Lawrence Grapefern | none | special concern | | Yes | Fire Dependent Forest | X |
| Botrychium simplex | Least Moonwort | none | special concern | | | Mesic Hardwood Forest | X |
| Botrychium spathulatum | Spatulate Moonwort | none | endangered | | | Fire Dependent Forest | X |
| Caltha natans | Floating Marsh Marigold | none | endangered | Yes | | Non-Forested Rich Peatland | X |
| Cardamine pratensis | Cuckoo Flower | none | threatened | Yes | | Forested Rich Peatland, Non-Forested Rich Peatland | X |
| Carex exilis | Coastal Sedge | none | special concern | | | Non-Forested Acid Peatland | X |
| Carex michauxiana | Michaux's Sedge | none | special concern | | | Forested Rich Peatland, Non-Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Carex ormostachya | Necklace Sedge | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Cladium mariscoides | Twig Rush | none | special concern | | | Non-Forested Rich Peatland | X |
| Crataegus douglasii | Black Hawthorn | none | special concern | | | Fire Dependent Forest | X |
| Cypripedium arietinum | Ram's Head Orchid | none | threatened | Yes | | Fire Dependent Forest, Forested Rich Peatland | X |
| Drosera anglica | English Sundew | none | special concern | | | Non-Forested Rich Peatland | X |
| Eleocharis flavescens var. olivacea | Olivaceous Spikerush | none | threatened | | | Non-Forested Acid Peatland | X |

| 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 |
|---|---|---|---|---|---|---|---|
| Eleocharis quinqueflora | Few-flowered Spikerush | none | special concern | | | Non-Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Gymnocarpium robertianum | Northern Oak Fern | none | special concern | | | Forested Rich Peatland | X |
| Huperzia porophila | Rock Fir Moss | none | threatened | Yes | | Mesic Hardwood Forest | X |
| Juncus stygius var. americanus | Bog Rush | none | special concern | | | Non-Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Listera convallarioides | Broad-leaved Twayblade | none | special concern | | | Forested Rich Peatland | X |
| Luzula parviflora | Small-flowered Woodrush | none | threatened | Yes | | Fire Dependent Forest, Mesic Hardwood Forest, Forested Rich Peatland | X |
| Malaxis monophyllos var. brachypoda | White Adder's Mouth | none | special concern | | | Forested Rich Peatland | X |
| Malaxis paludosa | Bog Adder's Mouth | none | endangered | | | Forested Rich Peatland | X |
| Moehringia macrophylla | Large-leaved Sandwort | none | threatened | Yes | | Fire Dependent Forest | X |
| Muhlenbergia uniflora | One-flowered Muhly | none | special concern | | | Non-Forested Acid Peatland | X |
| Osmorhiza berteroi | Chilean Sweet Cicely | none | endangered | Yes | | Mesic Hardwood Forest | X |
| Osmorhiza depauperata | Blunt-fruited Sweet Cicely | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Phacelia franklinii | Franklin's Phacelia | none | threatened | | Yes | Fire Dependent Forest | X |
| Piptatherum canadense | Canadian Ricegrass | none | threatened | Yes | | Fire Dependent Forest | X |
| Platanthera clavellata | Small Green Wood Orchid | none | special concern | | Yes | Forest Acid Peatland, Forested Rich Peatland | X |
| Polystichum braunii | Braun's Holly Fern | none | threatened | Yes | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Potamogeton confervoides | Algae-like Pondweed | none | endangered | Yes | | Non-Forested Acid Peatland | X |
| Prosartes trachycarpa | Rough-fruited Fairybells | none | endangered | Yes | | Fire Dependent Forest | X |
| Pyrola minor | Small Shinleaf | none | special concern | | | Fire Dependent Forest, Forest Acid Peatland, Forested Rich Peatland | X |
| Ranunculus lapponicus | Lapland Buttercup | none | special concern | | | Forested Rich Peatland | X |
| Rubus chamaemorus | Cloudberry | none | threatened | Yes | | Forest Acid Peatland | X |
| Rubus semisetosus | Swamp Blackberry | none | threatened | Yes | | Forested Rich Peatland | X |
| Shepherdia canadensis | Soapberry | none | special concern | | | Fire Dependent Forest | X |

| 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 |
|---|---|---|---|---|---|---|---|
| Trichophorum clintonii | Clinton's Bulrush | none | threatened | | | Fire Dependent Forest | X |
| Utricularia geminiscapa | Hidden-fruit Bladderwort | none | threatened | Yes | | Non-Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Waldsteinia fragarioides var. fragarioides | Barren Strawberry | none | special concern | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Xyris montana | Montane Yellow-eyed Grass | none | special concern | | Yes | Non-Forested Rich Peatland, Non-Forested Acid Peatland | X |

Table 3-12: Terrestrial Wildlife 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 | | Minnesota Department of Natural Resources Rare Species Guide Habitats | Potentially Present in Areas of Potential Ground Disturbance |
|---|---|---|---|---|---|---|---|---|---|
| Bird | | | | | | | | | |
| Accipiter gentilis | Northern Goshawk | none | special concern | Yes | Yes | Yes | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Aegolius funereus | Boreal Owl | none | special concern | Yes | | Yes | | Fire Dependent Forest, Mesic Hardwood Forest, Forested Rich Peatland | X |
| Haliaeetus leucocephalus | Bald Eagle | Eagle Act | delisted | | Yes | | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Cardellina Canadensis | Canada Warbler | Migratory Bird Act | none | | | | | not included in the MDNR rare species guide | X |
| Setophaga tigrina | Cape May Warbler | Migratory Bird Act | none | | | | | not included in the MDNR rare species guide | X |
| Coccothraustes vespertinus | Evening Grosbeak | Migratory Bird Act | none | | | | | not included in the MDNR rare species guide | X |

| 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 | | Minnesota Department of Natural Resources Rare Species Guide Habitats | Potentially Present in Areas of Potential Ground Disturbance |
|---|---|---|---|---|---|---|---|---|---|
| Insect | | | | | | | | | |
| Cicindela denikei | Laurentian Tiger Beetle | none | special concern | | | Yes | | Fire Dependent Forest | X |
| Ophiogomphus anomalus | Extra-striped Snaketail | none | special concern | | | Yes | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Plebejus idas nabokovi | Nabokov's Blue | none | special concern | Yes | | Yes | | Fire Dependent Forest | X |
| Somatochlora forcipata | Forcipate Emerald | none | special concern | | | Yes | | Forested Rich Peatland, Non-Forested Rich Peatland | X |
| Mammal | | | | | | | | | |
| Canis lupus lycaon | Gray Wolf | threatened | delisted | | Yes | | | | X |
| Eptesicus fuscus | Big Brown Bat | none | special concern | | | Yes | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Lynx canadensis | Canada Lynx | threatened | special concern | | | Yes | | | X |
| Myotis lucifugus | Little Brown Myotis | none | special concern | Yes | | Yes | Yes | Mesic Hardwood Forest | X |
| Myotis septentrionalis | Northern Long-eared Bat | threatened | special concern | | | Yes | | Fire Dependent Forest, Mesic Hardwood Forest | X |
| Phenacomys ungava | Eastern Heather Vole | none | special concern | Yes | | Yes | Yes | Fire Dependent Forest, Non-Forested Rich Peatland, Non-Forested Acid Peatland | X |
| Sorex fumeus | Smoky Shrew | none | special concern | | | Yes | | Fire Dependent Forest, Mesic Hardwood Forest, Forest Acid Peatland, Forested Rich Peatland | X |
| Synaptomys borealis | Northern Bog Lemming | none | special concern | | | Yes | | Forest Acid Peatland, Forested Rich Peatland, Non-Forested Rich Peatland, Non-Forested Acid Peatland | no[1] |
| Reptile | | | | | | | | | |
| Emydoidea blandingii | Blanding's Turtle | none | threatened | | | Yes | | Forested Rich Peatland | X |

| 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 | | Minnesota Department of Natural Resources Rare Species Guide Habitats | Potentially Present in Areas of Potential Ground Disturbance |
|---|---|---|---|---|---|---|---|---|---|
| Spider | | | | | | | | | |
| Habronattus calcaratus maddisoni | A Jumping Spider | none | special concern | | | | | Fire Dependent Forest | no[2] |

Notes:

[1] Northern bog lemming need large tracts of suitable peatland (MDNR, 2019d) which are not present in the areas of potential ground disturbance. Therefore it is not expected that the Project would have an impact to the northern bog lemming.

[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.

Table 3-13: Aquatic Sensitive 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 Ground Disturbance |
|---|---|---|---|---|---|---|---|---|
| Bird | | | | | | | | |
| Cygnus buccinator | Trumpeter Swan | none | special concern | | Yes | | Littoral Zone of Lake | |
| Sterna hirundo | Common Tern | none | threatened | | Yes | | Littoral Zone of Lake, Deep Water Zone of Lake | |
| Fish | | | | | | | | |
| Acipenser fulvescens | Lake Sturgeon | none | special concern | Yes | Yes | | Littoral Zone of Lake, Deep Water Zone of Lake | |
| Coregonus nipigon | Nipigon Cisco | none | special concern | Yes | Yes | | Deep Water Zone of Lake | |
| Coregonus zenithicus | Shortjaw Cisco | none | special concern | Yes | Yes | | Deep Water Zone of Lake | |
| Couesius plumbeus | Lake Chub | none | special concern | | Yes | | Littoral Zone of Lake, Small Rivers and Streams | |
| Ichthyomyzon fossor | Northern Brook Lamprey | none | special concern | Yes | Yes | | Small Rivers and Streams | |
| Lepomis peltastes | Northern Sunfish | none | special concern | | Yes | | Littoral Zone of Lake | |
| Insect | | | | | | | | |
| Boyeria grafiana | Ocellated Darner | none | special concern | | Yes | | Small Rivers and Streams | |

| 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 Ground Disturbance |
|---|---|---|---|---|---|---|---|---|
| Goera stylata | A Caddisfly | none | threatened | Yes | Yes | | Small Rivers and Streams | |
| Holocentropus glacialis | A Caddisfly | none | threatened | | | | Littoral Zone of Lake | |
| Ochrotrichia spinosa | A Purse Casemaker Caddisfly | none | endangered | | Yes | | Small Rivers and Streams | |
| Ophiogomphus anomalus | Extra-striped Snaketail | none | special concern | | Yes | | Small Rivers and Streams | |
| Triaenodes flavescens | A Triaenode Caddisfly | none | special concern | | Yes | | Small Rivers and Streams | |
| Mussel | | | | | | | | |
| Lasmigona compressa | Creek Heelsplitter | none | special concern | Yes | Yes | | Small Rivers and Streams | |
| Reptile | | | | | | | | |
| Emydoidea blandingii | Blanding's Turtle | none | threatened | | Yes | | Small Rivers and Streams | |
| Vascular Plant | | | | | | | | |
| Callitriche heterophylla | Larger Water Starwort | none | threatened | Yes | | | Littoral Zone of Lake | |
| Caltha natans | Floating Marsh Marigold | none | endangered | Yes | | | Small Rivers and Streams | |
| Carex flava | Yellow Sedge | none | special concern | | | | Small Rivers and Streams | |
| Cladium mariscoides | Twig Rush | none | special concern | | | | Littoral Zone of Lake | |
| Crassula aquatica | Water Pygmyweed | none | threatened | | | | Littoral Zone of Lake | |
| Elatine triandra | Three-stamened Waterwort | none | special concern | | | | Littoral Zone of Lake | |
| Eleocharis robbinsii | Robbins' Spikerush | none | threatened | | | | Littoral Zone of Lake | |
| Juncus subtilis | Slender Rush | none | endangered | Yes | | | Littoral Zone of Lake | |
| Littorella americana | American Shore Plantain | none | special concern | | | | Littoral Zone of Lake | |
| Myriophyllum heterophyllum | Broadleaf Water Milfoil | none | special concern | | | | Littoral Zone of Lake | |
| Najas gracillima | Slender Naiad | none | special concern | | | | Littoral Zone of Lake | |
| Nymphaea leibergii | Small White Waterlily | none | threatened | Yes | | | Littoral Zone of Lake, Small Rivers and Streams | |
| Potamogeton oakesianus | Oakes' Pondweed | none | endangered | Yes | | | Littoral Zone of Lake | |
| Subularia aquatica ssp. americana | Awlwort | none | threatened | Yes | | | Littoral Zone of Lake | |
| Torreyochloa pallida | Torrey's Mannagrass | none | special concern | | | | Littoral Zone of Lake, Small Rivers and Streams | |
| Utricularia resupinata | Lavender Bladderwort | none | threatened | Yes | | | Littoral Zone of Lake | |

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Table 3-14: 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 Sruvey 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 Sruvey 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 Arcaheological 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 |

| Author | Year | Report Title |
|---|---|---|
| 106 Group | 2019b | Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Non-Federal Public Lands, Lake County, Minnesota |

Table 3-15: 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. PM2.5 data were obtained from Ely, Minnesota (0005). Using MPCA guidance for calculation of background concentrations, the PM2.5 24-hour background concentration is the average of the 98th percentile 24-hour values over three years. The PM2.5 annual background concentration is the average of the annual mean concentration over three years. PM10 data were obtained from Silver Bay (7640-1), near the North Shore Mining site. The PM10 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 SO2 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 SO2 and NO2 concentrations are the average of the annual mean concentration over three years. The 24-hour and 3-hour SO2 background concentrations are the second-high values over three years.

The 1-hour NO2 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:

μg/m3 = micrograms per cubic meter
Avg = average
Hr = hour
PM = particulate matter

Table 3-16: 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
$L_{eq}$ = equivalent continuous sound level

Table 3-17: 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 |

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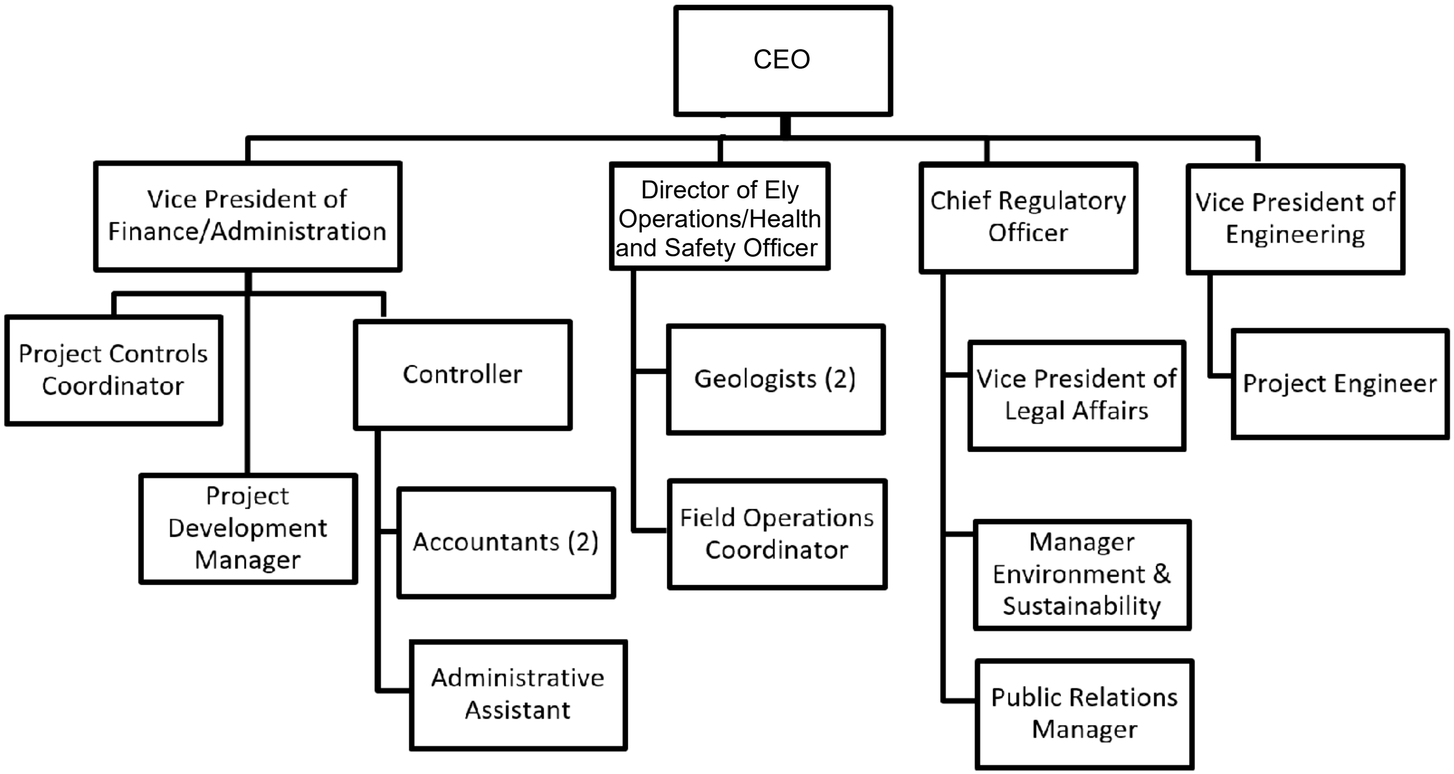
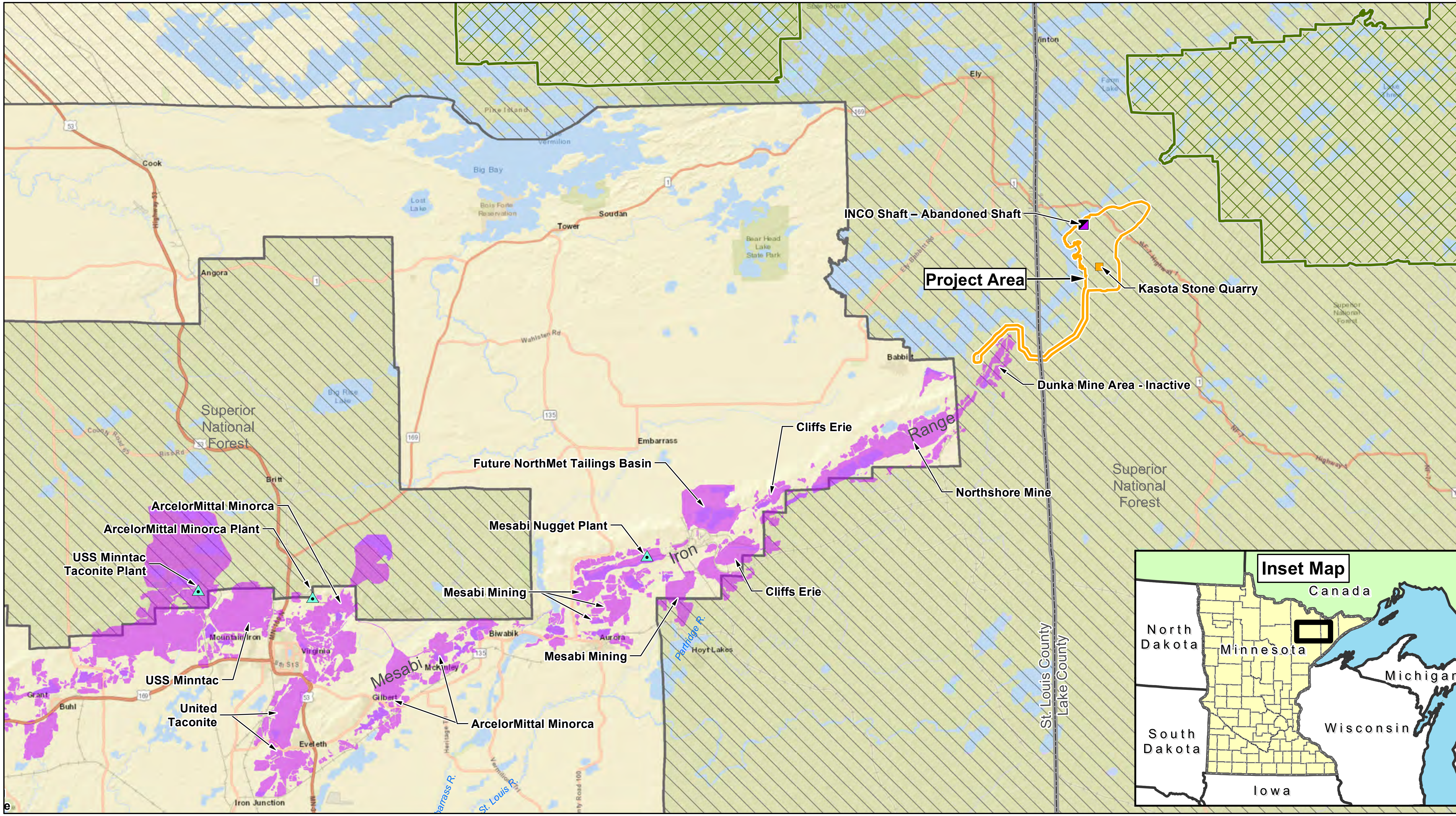



TWIN METALS MINNESOTA

**FIGURE 1-1**

ORGANIZATIONAL STRUCTURE

| | |
|---|---|
| Scale: Not to Scale | Date: 09/19/2019 |




**NOTES**

1. Basemap from Esri and its data suppliers.
2. Boundary data from the MDNR.
3. Mining related data from MDNR Division of Lands and Minerals via email.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- INCO Shaft – Abandoned Shaft
- Kasota Stone Quarry
- Existing Taconite Plant
- County Boundary
- Project Area
- Superior National Forest Administrative Boundary (does not indicate surface ownership)
- Boundary Waters Canoe Area Wilderness
- Mesabi Range Mining Features (Existing Pits, Tailings Basins, Stockpiles and other Mine Features)

TWIN METALS MINNESOTA

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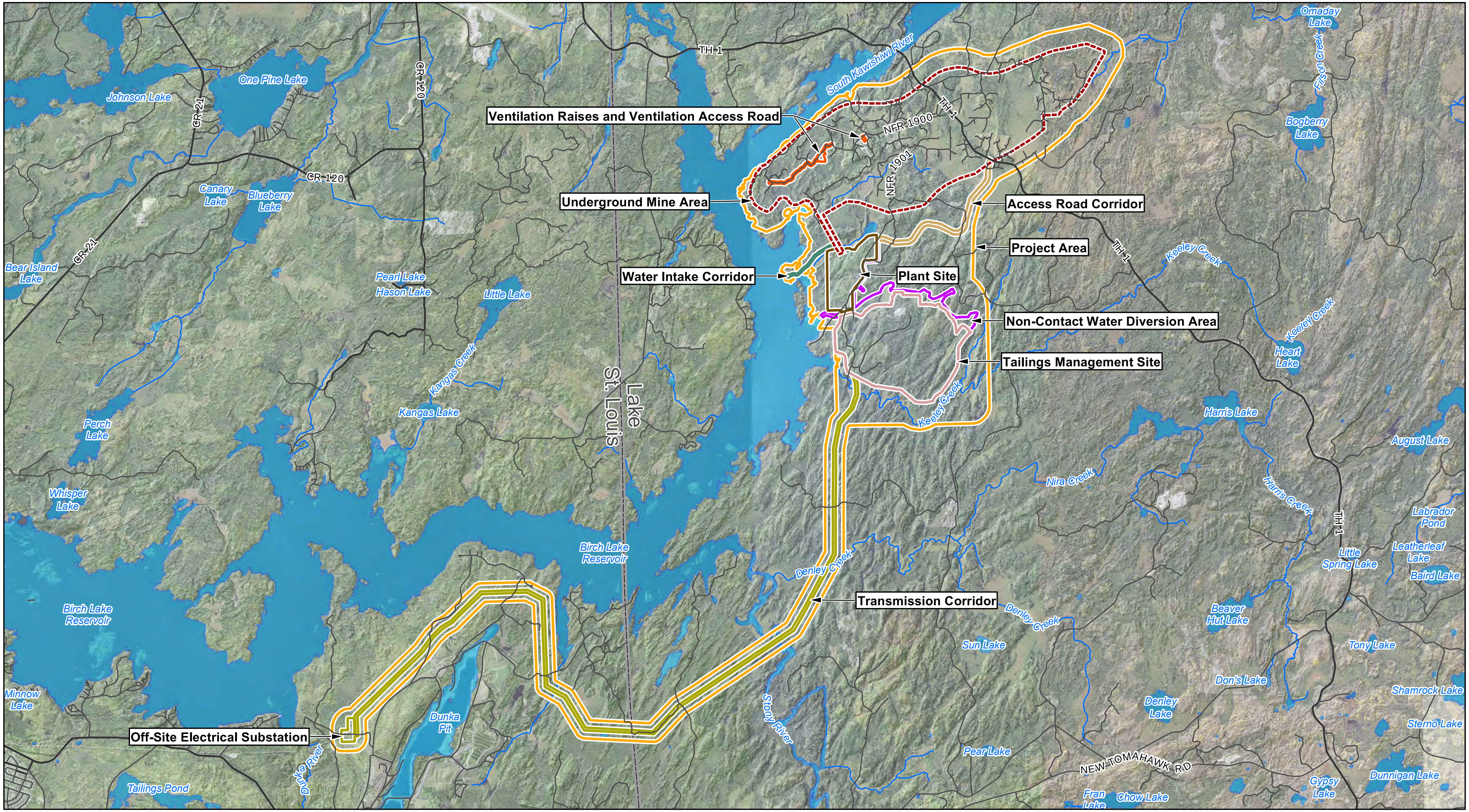
TWIN METALS MINNESOTA

**FIGURE 2-1**

PROJECT LOCATION

Scale: 0 2 4 Miles

Date: AUGUST 2019




**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**

- 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

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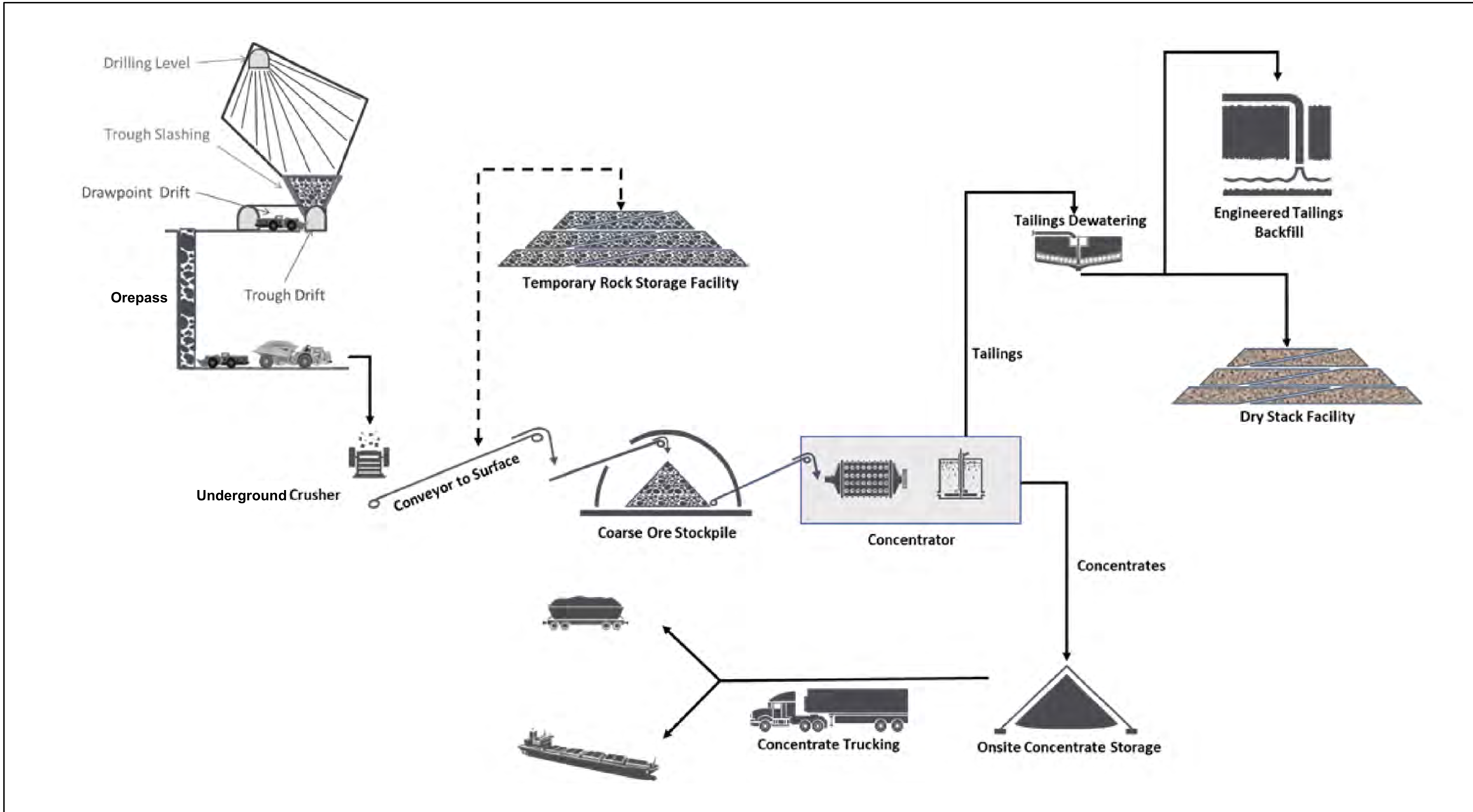
TWIN METALS MINNESOTA

**FIGURE 2-2**

GENERAL PROJECT LAYOUT

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



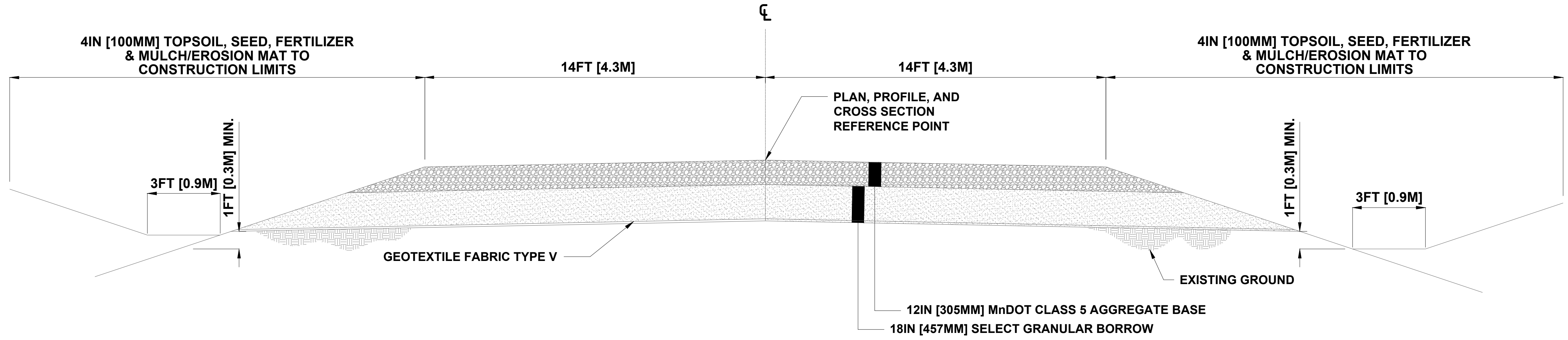

TWIN METALS MINNESOTA

TWIN METALS MINNESOTA

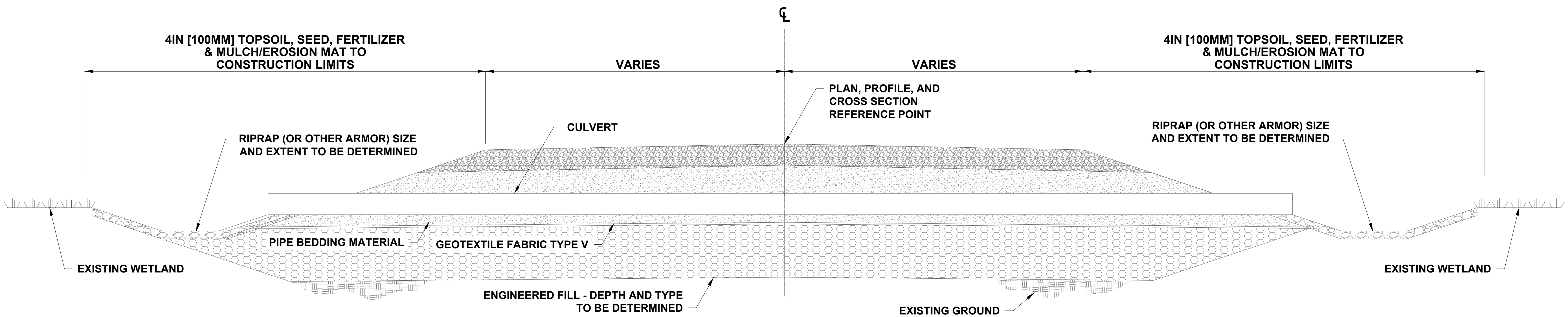
**FIGURE 2-3**

SIMPLIFIED PROJECT SCHEMATIC

Scale: Not to Scale | Date: 09/19/2019



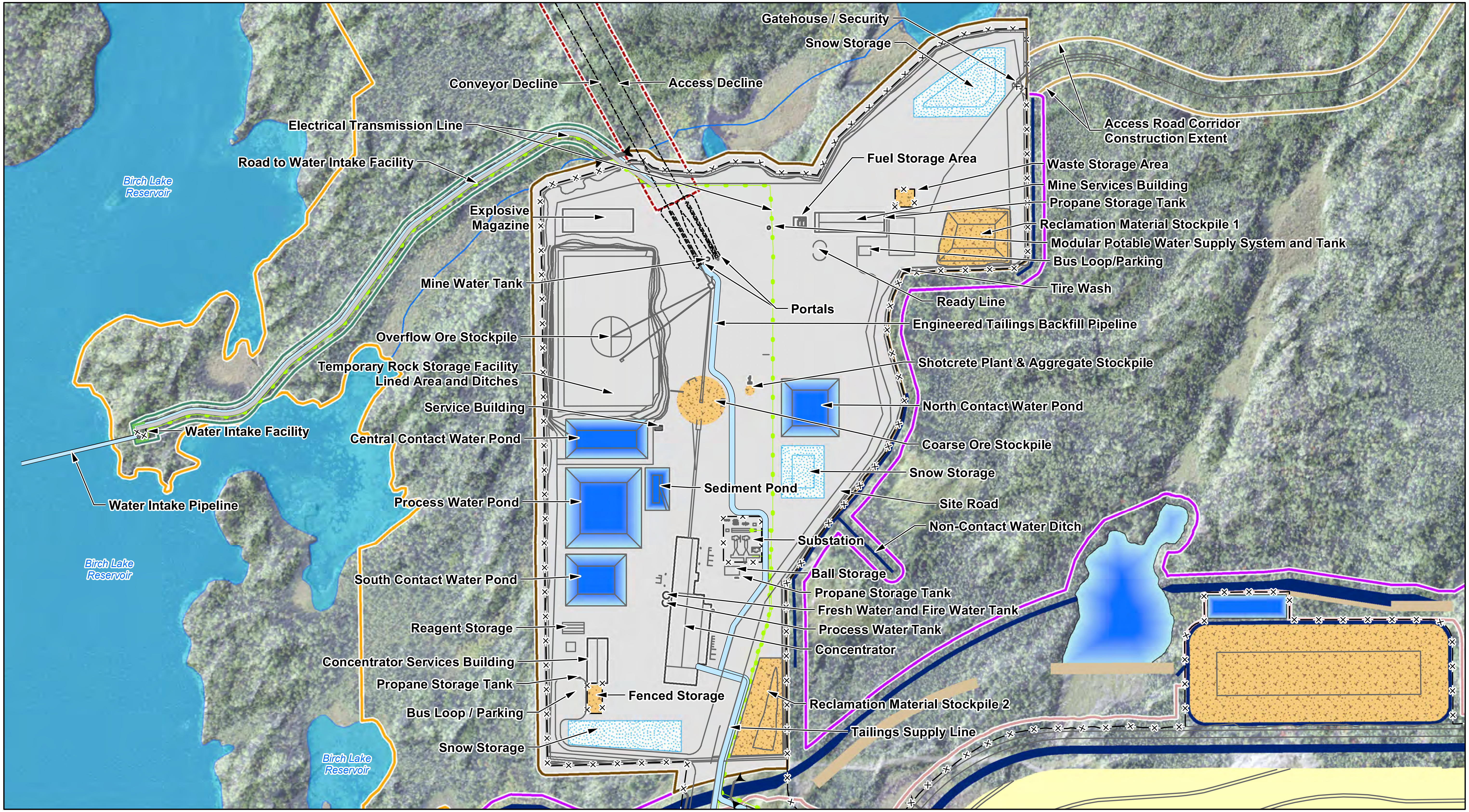

TYPICAL SECTION




TYPICAL SECTION W/CULVERT

TWIN METALS MINNESOTA

| TWIN METALS MINNESOTA | |
|---|---|
| **FIGURE 2-4** ACCESS ROAD TYPICAL SECTIONS | |
| SCALE: | DATE: SEPTEMBER 2019 |




**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**

- Facility
- Decline
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Water Intake Corridor
- Access Road Corridor

TWIN METALS MINNESOTA

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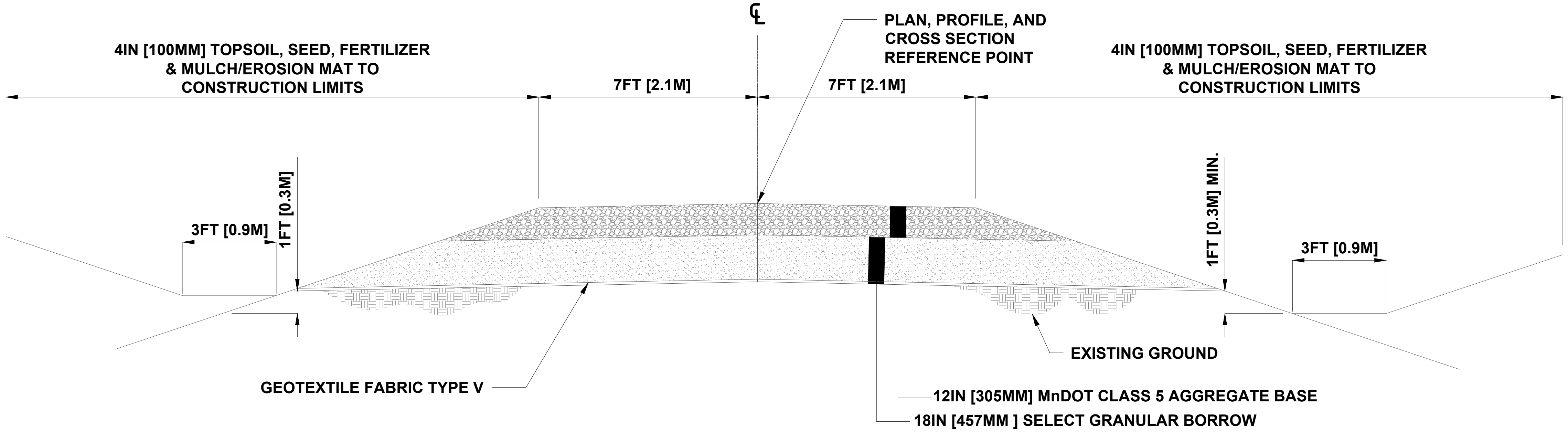
TWIN METALS MINNESOTA

**FIGURE 2-5**

PLANT SITE LAYOUT

Scale: 0 250 500 Feet

Date: SEPTEMBER 2019




TYPICAL SECTION SINGLE LANE ROAD

TWIN METALS MINNESOTA

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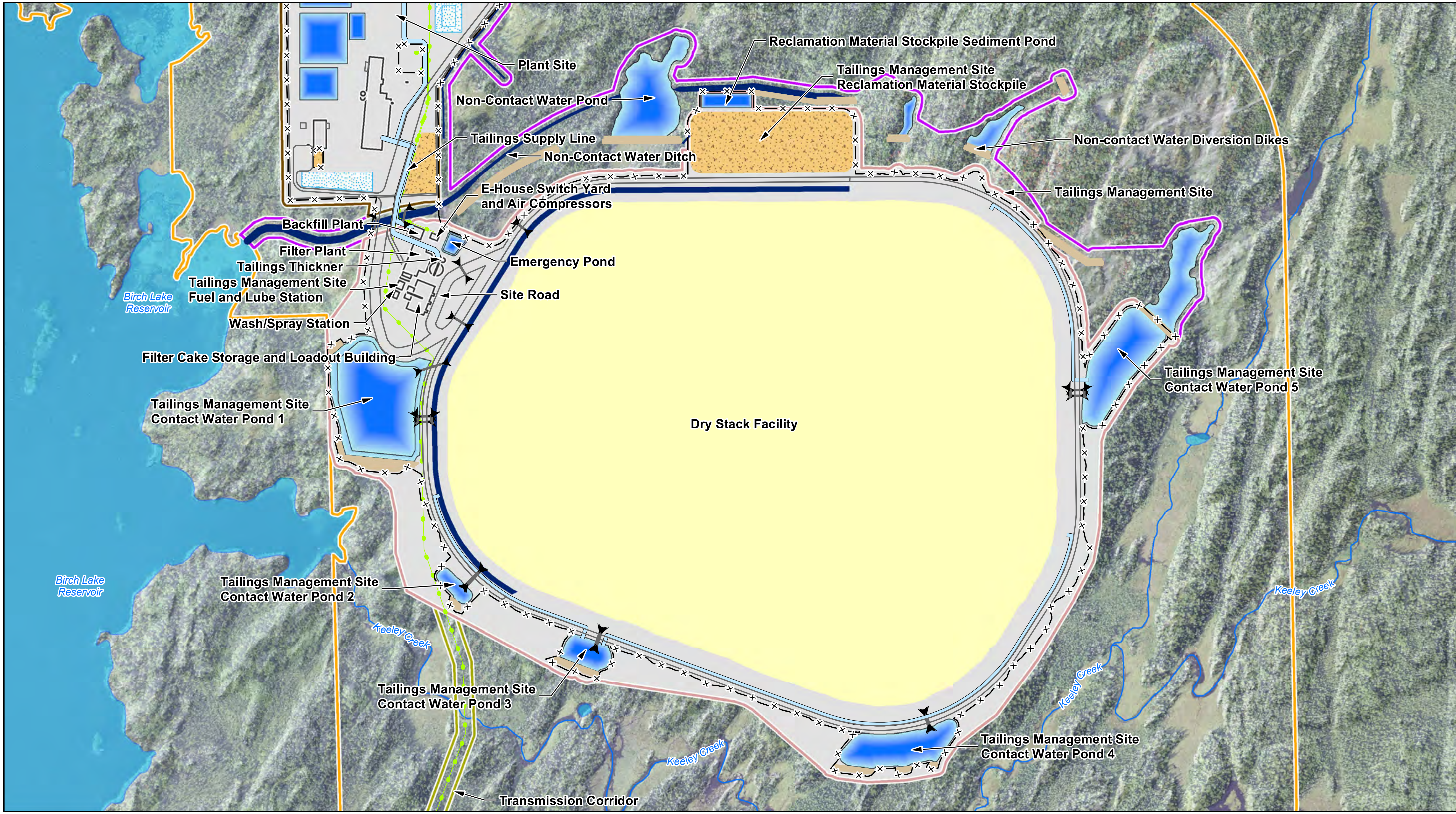
| TWIN METALS MINNESOTA | |
|---|---|
| **FIGURE 2-6**<br>SINGLE LANE ROAD<br>TYPICAL SECTION | |
| SCALE: | DATE: SEPTEMBER 2019 |




**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**

- Facility
- Piping
- Dike; Berm
- Culvert
- Electrical Transmission Line
- Fence
- River/Stream
- Lake/Pond
- Project Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor

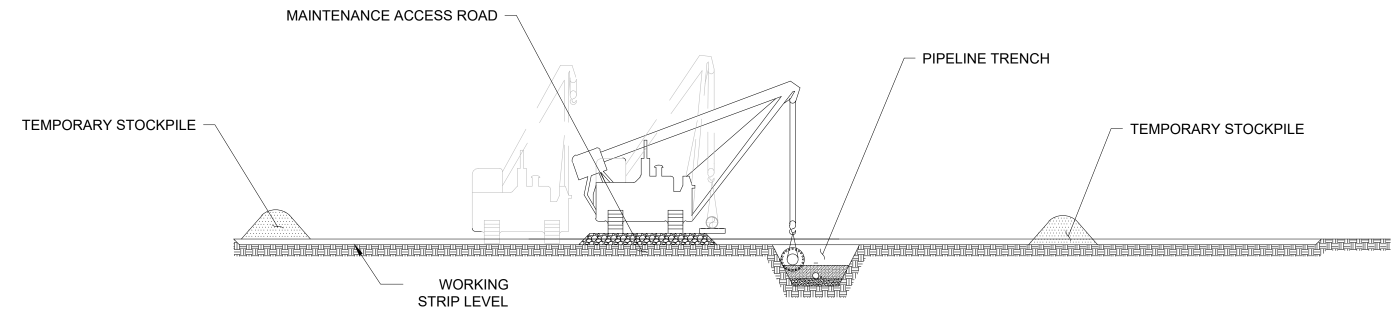
TWIN METALS MINNESOTA

TWIN METALS MINNESOTA

**FIGURE 2-7**

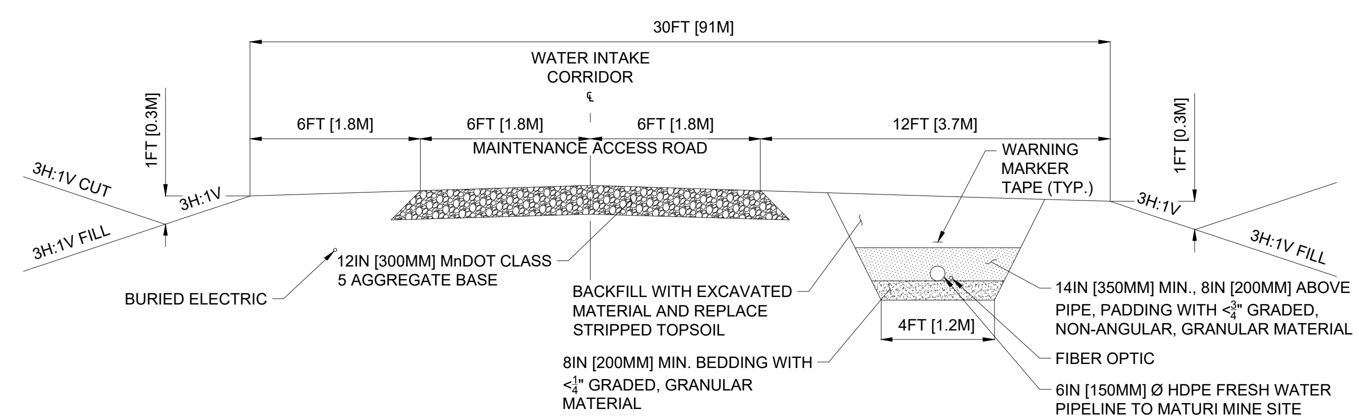
TAILINGS MANAGEMENT SITE LAYOUT

Date: SEPTEMBER 2019




SECTION: WATER INTAKE CORRIDOR (TYP.)

1:100 SCALE IN METERS (0–10) 1:100 SCALE IN FEET (0–30)




SECTION: WATER INTAKE CORRIDOR (TYP.)

1:40 SCALE IN METERS (0–4) 1:40 SCALE IN FEET (0–12)

NOTES:

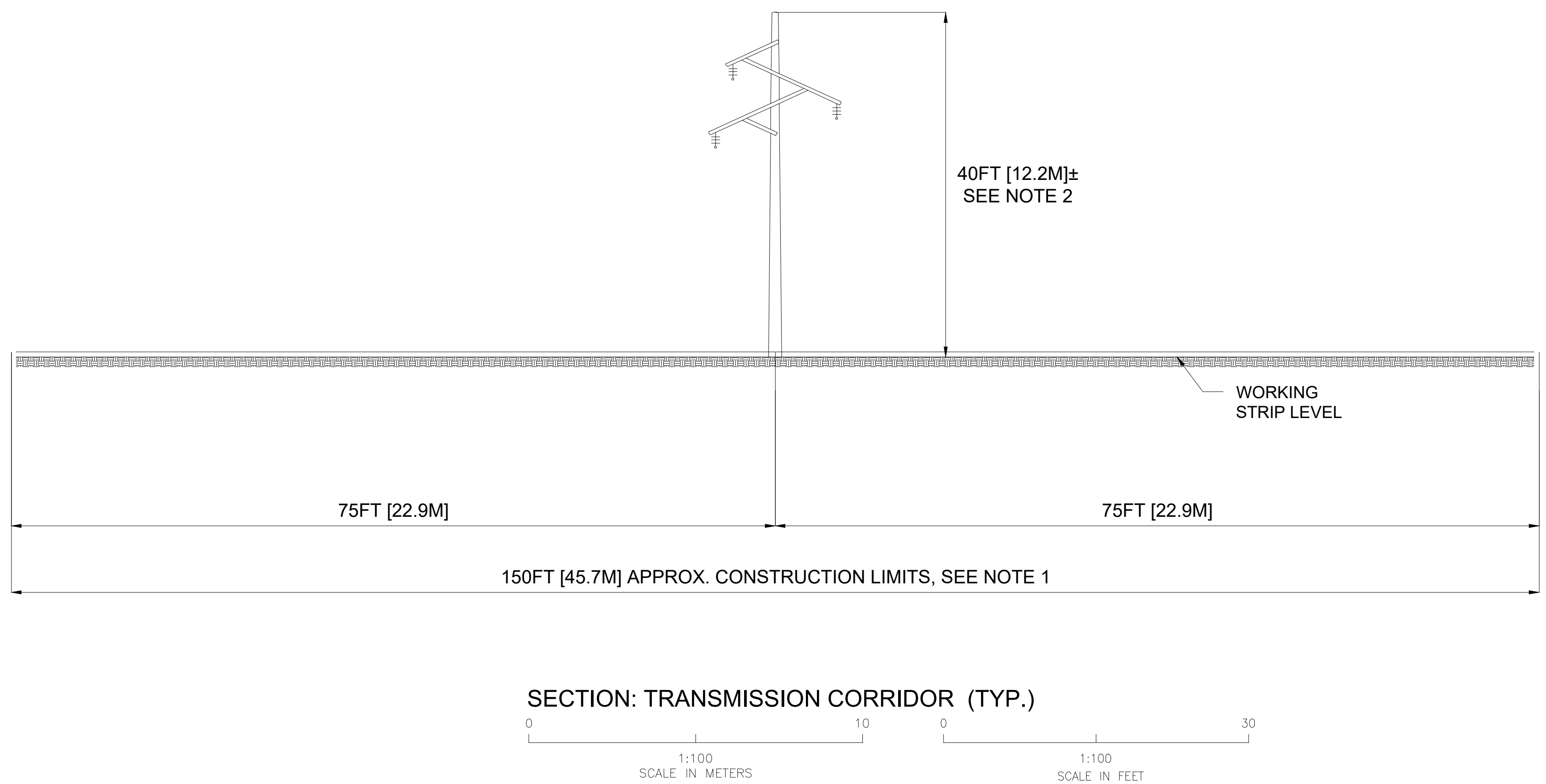
1. CLEARING AND TEMPORARY DISTURBANCE LIMITS WILL BE CONTAINED WITHIN THE APPROXIMATE CONSTRUCTION LIMITS SHOWN. CLEARING AND TEMPORARY DISTURBANCE WILL VARY BY LOCATION AND WILL BE LIMITED TO THE EXTENT PRACTICABLE IN ORDER TO FACILITATE INFRASTRUCTURE CONSTRUCTION INCLUDING GRADING, TEMPORARY AND FUTURE ACCESS, AND MATERIAL STAGING AND LAYDOWN.

TWIN METALS MINNESOTA

**FIGURE 2-8**

WATER INTAKE AND CORRIDOR TYPICAL SECTIONS

| SCALE: | DATE: SEPTEMBER 2019 |
| --- | --- |




SECTION: TRANSMISSION CORRIDOR (TYP.)

NOTES:

1. CLEARING AND TEMPORARY DISTURBANCE LIMITS WILL BE CONTAINED WITHIN THE APPROXIMATE CONSTRUCTION LIMITS SHOWN. CLEARING AND TEMPORARY DISTURBANCE WILL VARY BY LOCATION AND WILL BE LIMITED TO THE EXTENT PRACTICABLE IN ORDER TO FACILITATE INFRASTRUCTURE CONSTRUCTION INCLUDING GRADING, TEMPORARY AND FUTURE ACCESS, AND MATERIAL STAGING AND LAYDOWN.

2. THE NUMBER AND HEIGHT OF POWER POLES WILL VARY BASED ON THE VOLTAGE SELECTED DURING FUTURE PROJECT DEVELOPMENT.

TWIN METALS MINNESOTA

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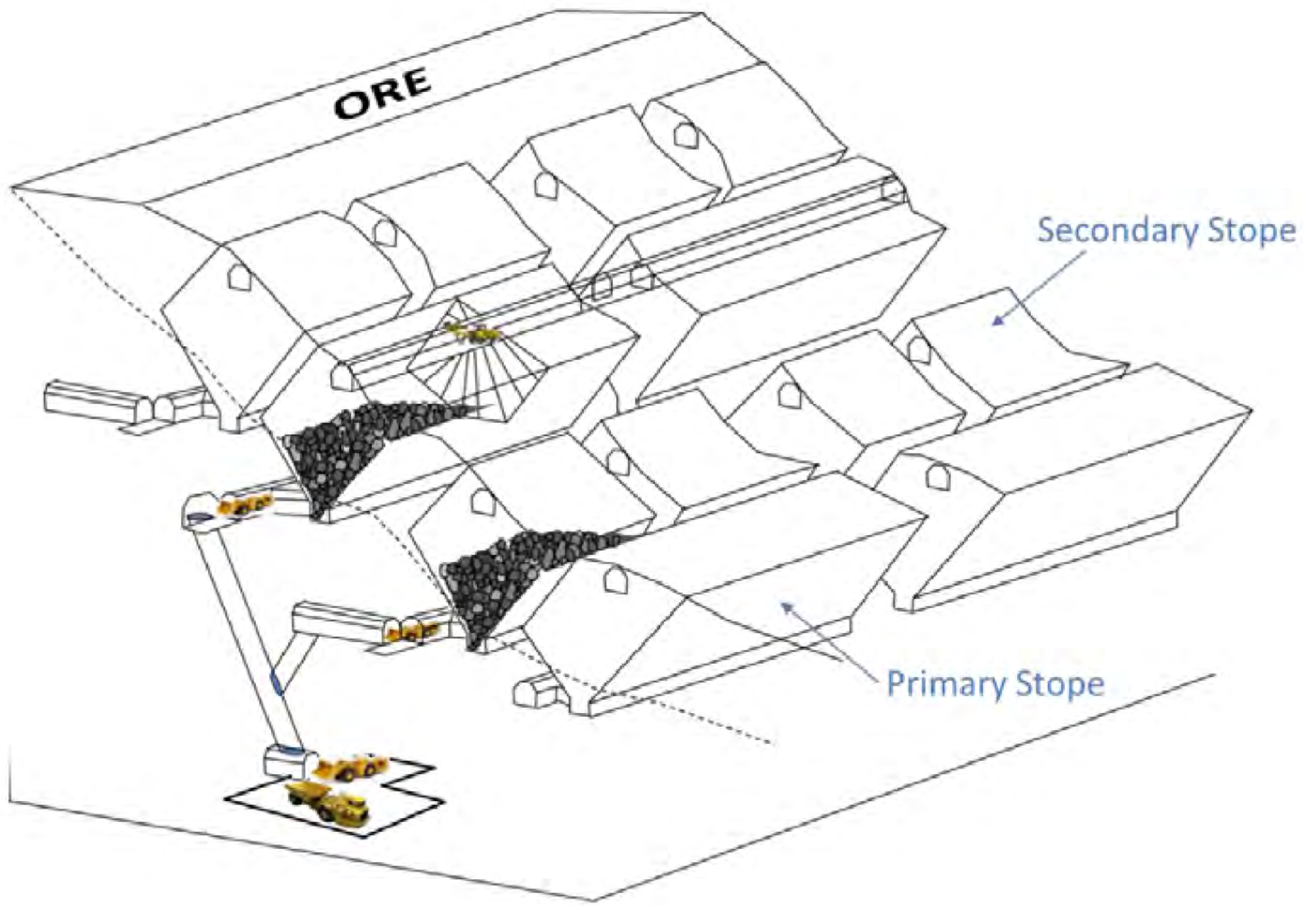
| TWIN METALS MINNESOTA | |
|---|---|
| **FIGURE 2-9**<br>TRANSMISSION CORRIDOR<br>TYPICAL SECTION | |
| SCALE: | DATE: SEPTEMBER 2019 |



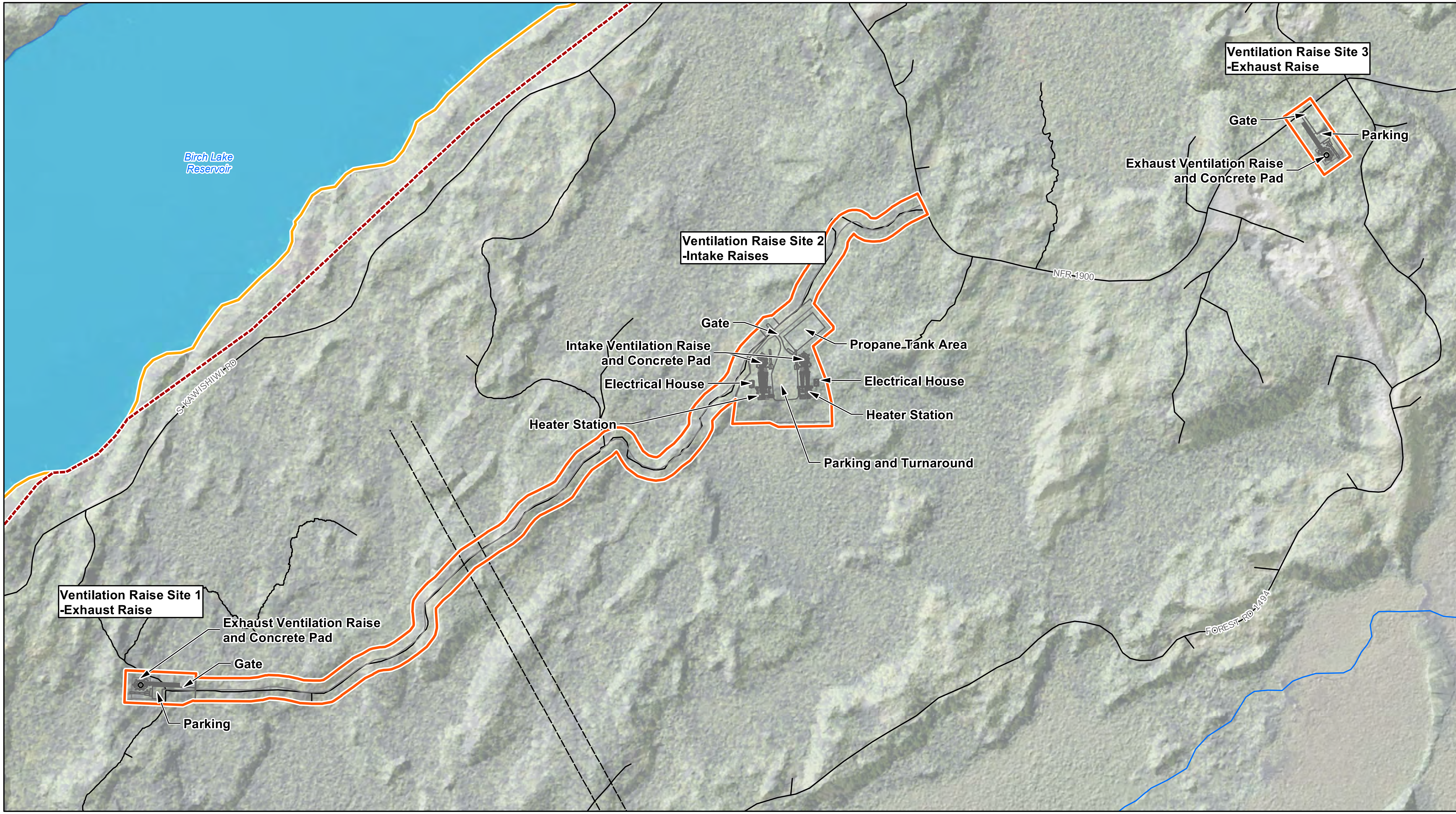

TWIN METALS MINNESOTA

TWIN METALS MINNESOTA

**FIGURE 2-10**

MINING METHOD SCHEMATIC

| | | | |
|---|---|---|---|
| Scale: | Not to Scale | Date: 09/24/2019 | |




**NOTES:**

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Digital elevation model hillshade downloaded from MnTopo.
3. Hydrographic data from Minnesota Department of Natural Resources.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- Facilities
- Decline
- Secondary Road
- River/Stream
- Lake/Pond
- Ventilation Raises and Ventilation Raise Access Road
- Underground Mine Area
- Project Area

TWIN METALS MINNESOTA

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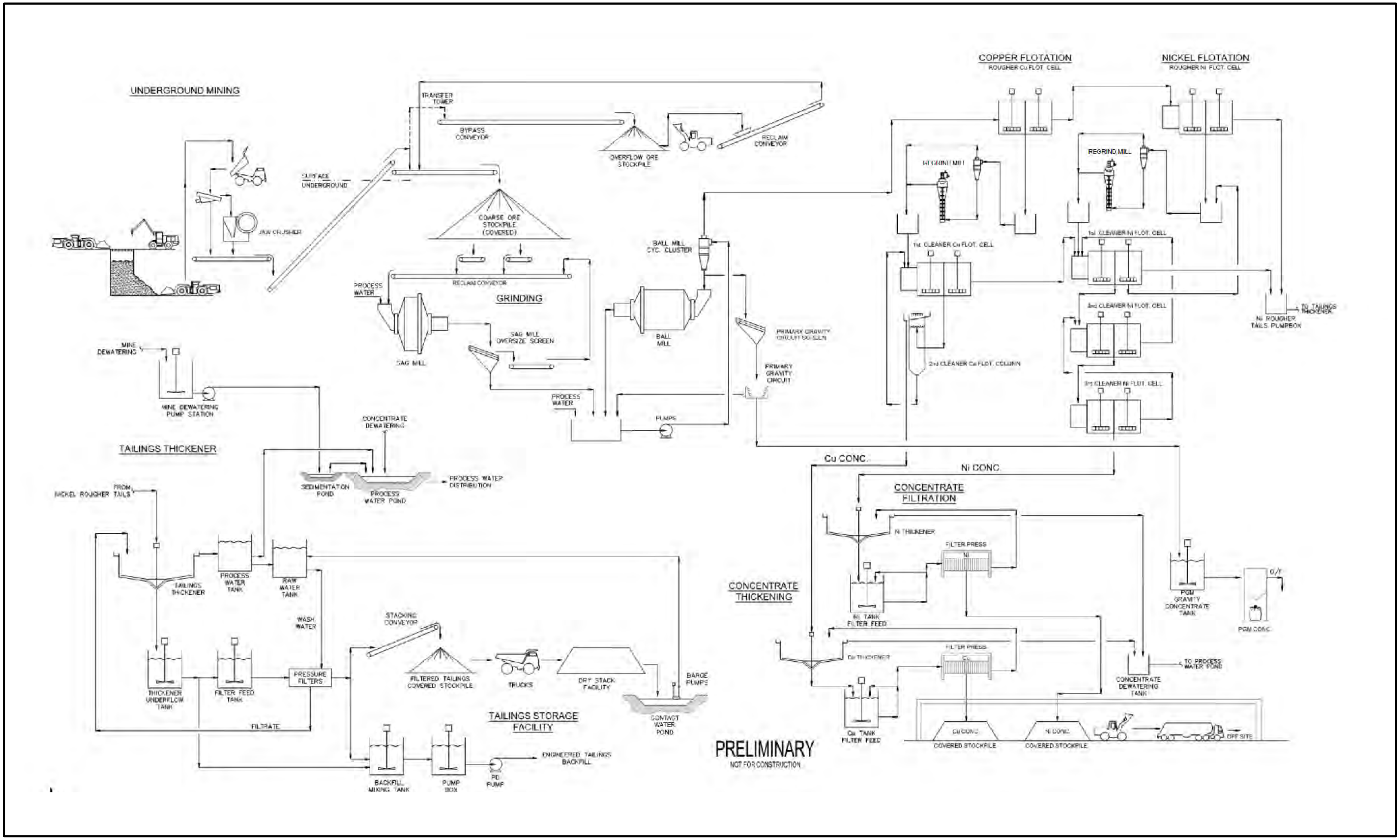
TWIN METALS MINNESOTA

**FIGURE 2-11**

VENTILATION RAISE LAYOUTS

Scale: 0 200 400 Feet

Date: SEPTEMBER 2019

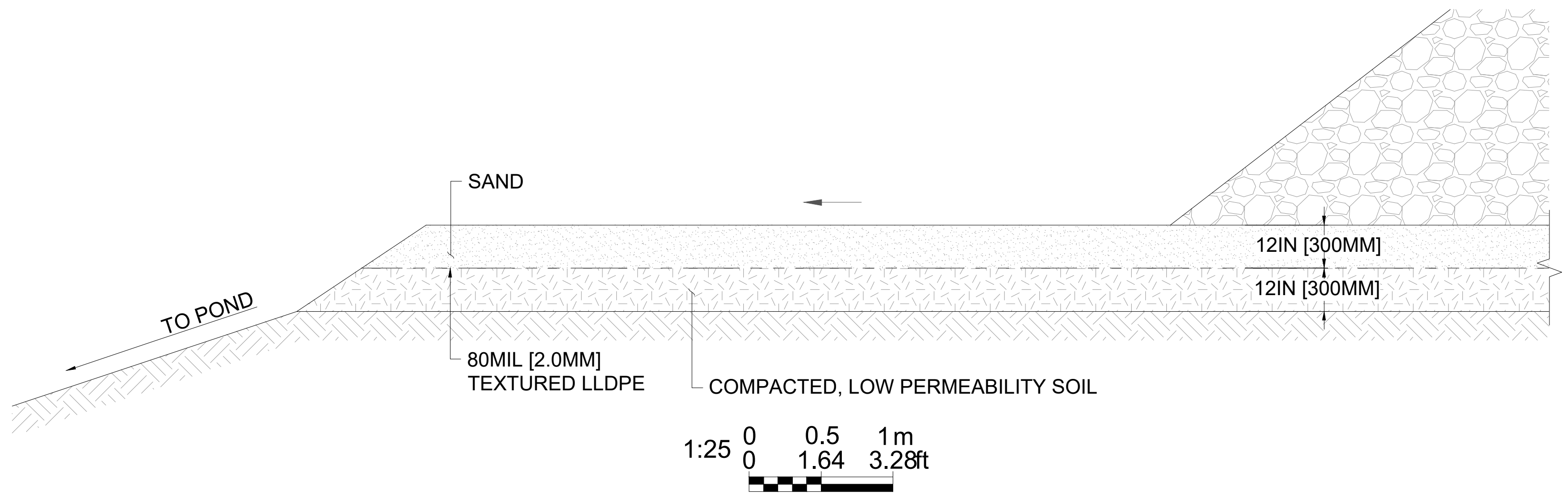


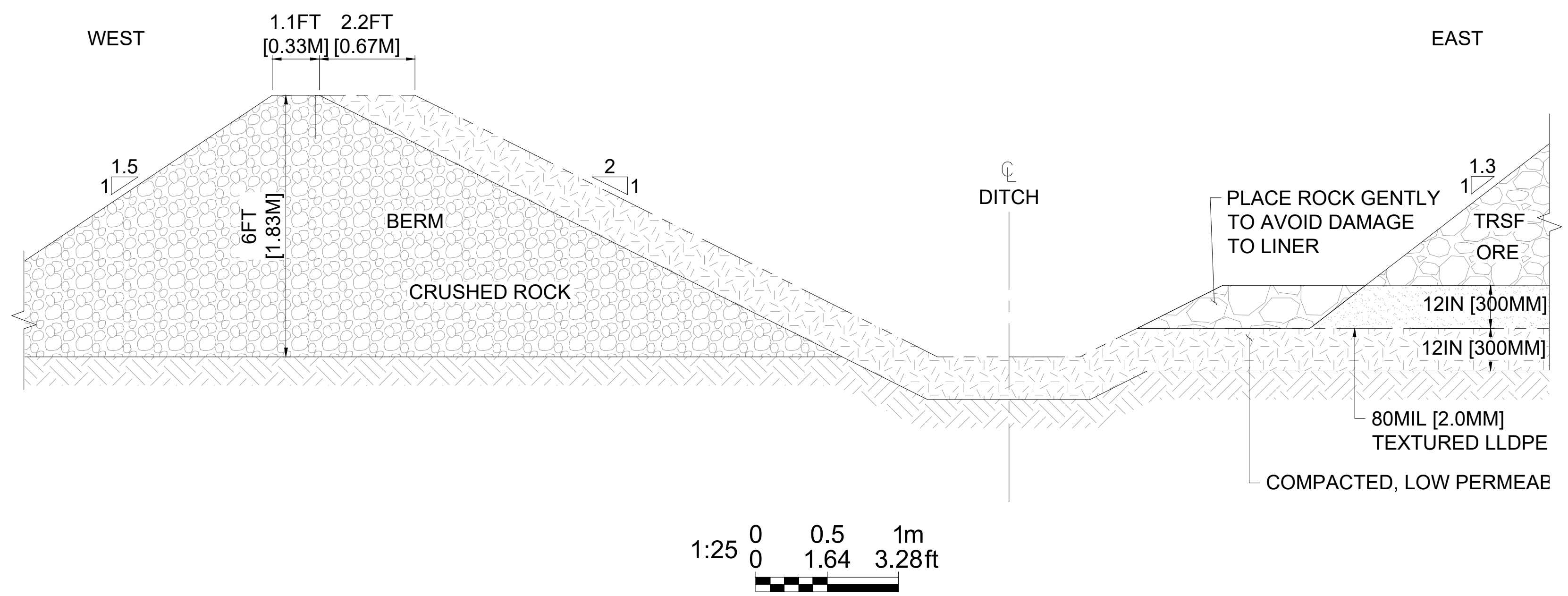

TWIN METALS MINNESOTA

**FIGURE 2-12**

OVERALL PROCESS FLOW DIAGRAM

| | |
|---|---|
| Scale: Not to Scale | Date: 09/23/2019 |



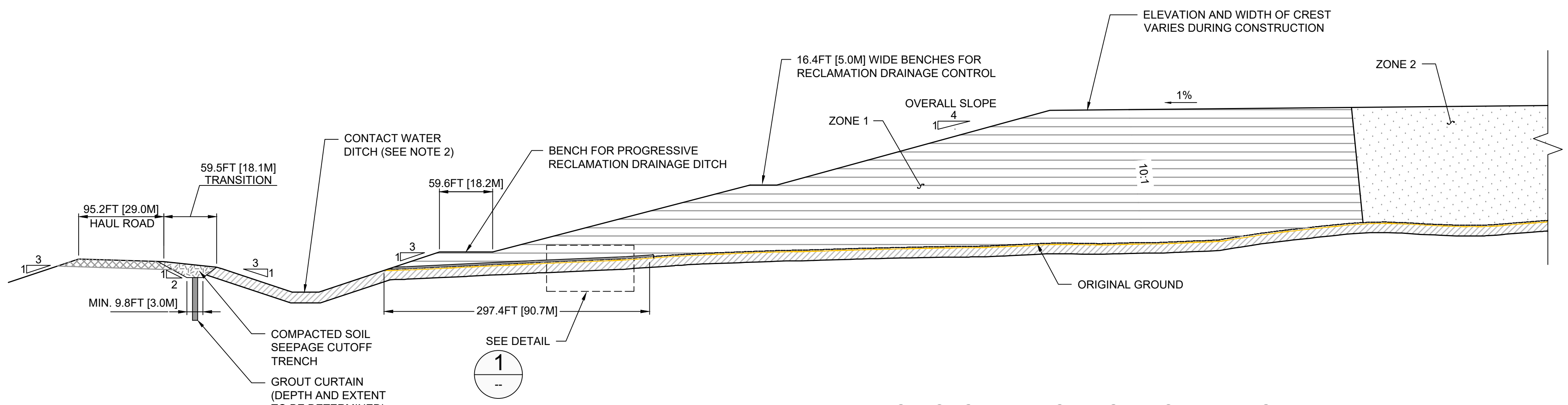




TWIN METALS MINNESOTA

**FIGURE 2-13**

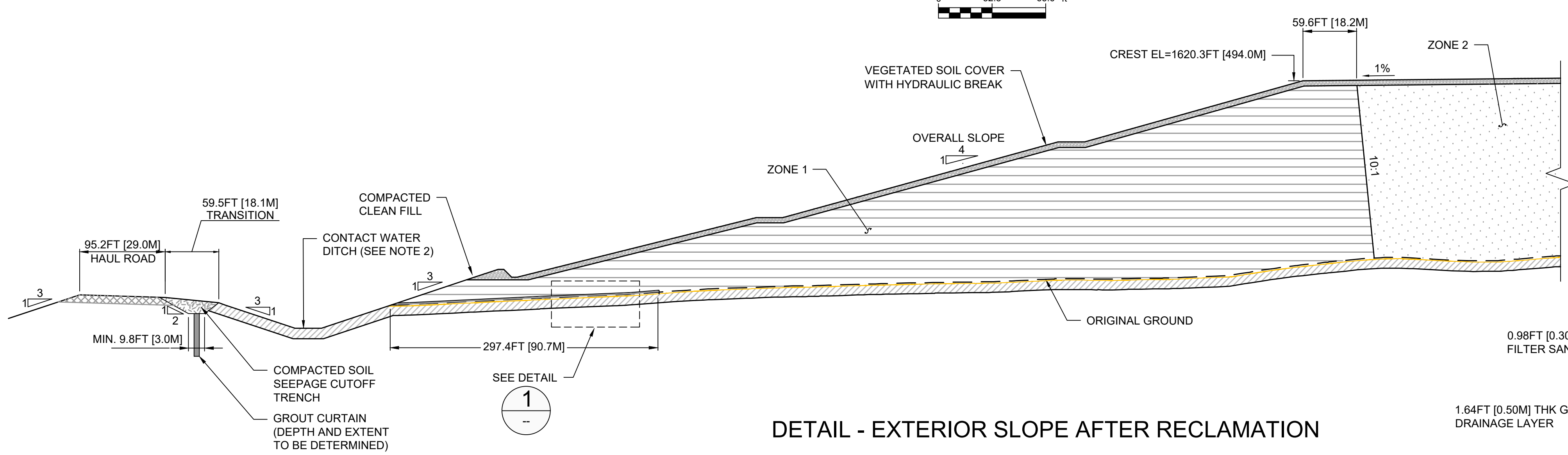
TEMPORARY ROCK STORAGE FACILITY SECTIONS

| SCALE: | DATE: SEPTEMBER 2019 |
|---|---|
| | |



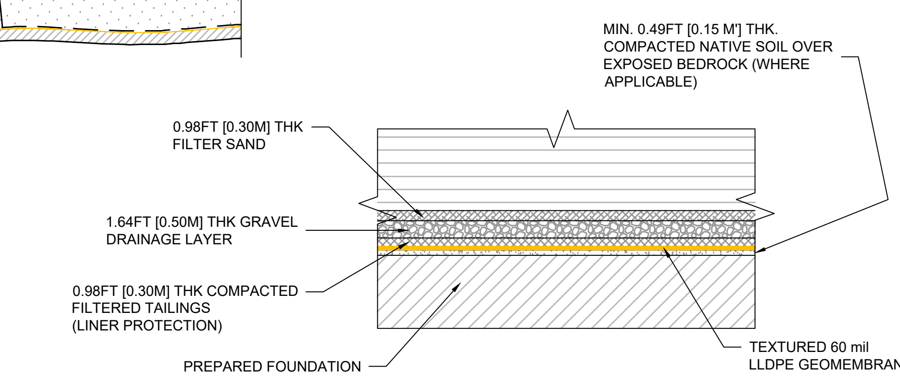

DETAIL - EXTERIOR SLOPE PRIOR TO RECLAMATION

1:1000 0 10 20 m / 0 32.8 65.6 ft




DETAIL - EXTERIOR SLOPE AFTER RECLAMATION

1:1000 0 10 20 m / 0 32.8 65.6 ft




1 BLANKET TOE DRAIN DETAIL

1:200 0 2.0 4.0 m / 0 6.6 13.1 ft

## LEGEND:

- ORIGINAL GROUND (20160426)
- PREPARED SURFACE
- ZONE 1 DENSELY COMPACTED TAILINGS (STRUCTURAL SHELL)
- ZONE 2 MODERATELY COMPACTED TAILINGS (NON-STRUCTURAL)
- SAND FILTER
- GRAVEL BLANKET TOE DRAIN
- COMPACTED ROAD FILL
- DRAIN SAND
- 60 mil LLDPE GEOMEMBRANE
- SOIL COVER
- COMPACTED SOIL SEEPAGE CUTOFF TRENCH
- GROUT CURTAIN
- COMPACTED CLEAN FILL

## 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.

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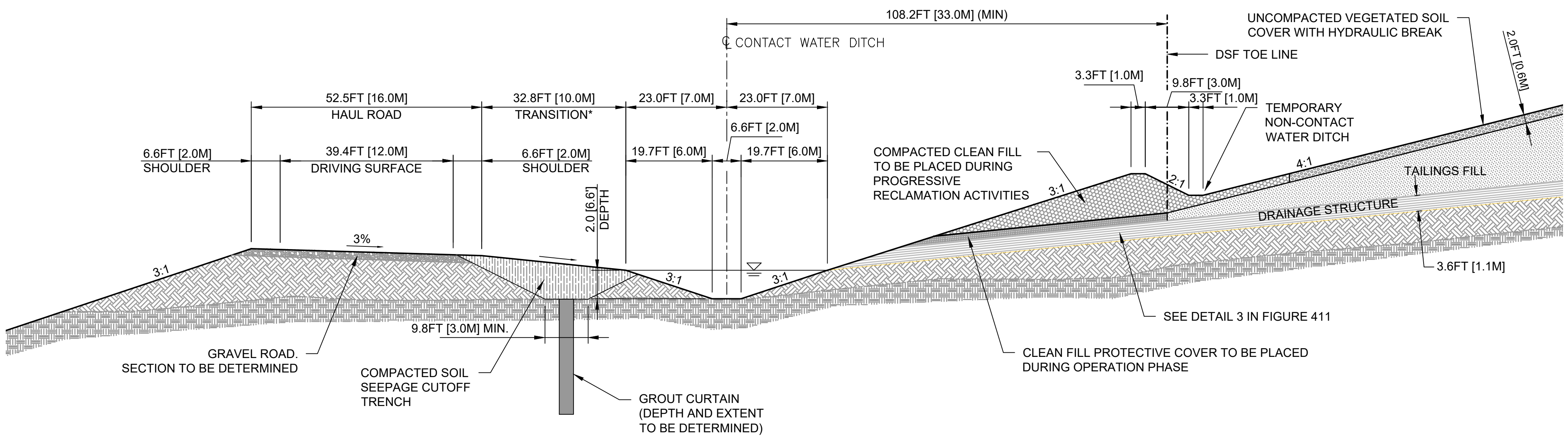
TWIN METALS MINNESOTA

**FIGURE 2-14**
TYPICAL CROSS SECTION OF EXTERIOR SLOPE

SCALE:

DATE: SEPTEMBER 2019




*NOTE ABOUT TRANSITION SLOPE:

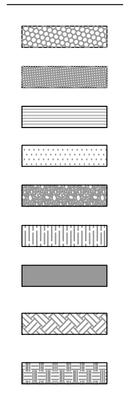
SLOPES THROUGH TRANSITION WILL VARY DEPENDING ON MATERIAL AS FOLLOWS:

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)

## TYPICAL PERIMETER CONTACT WATER DITCH DETAIL

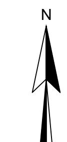
SCALE = 1:400

## LEGEND:

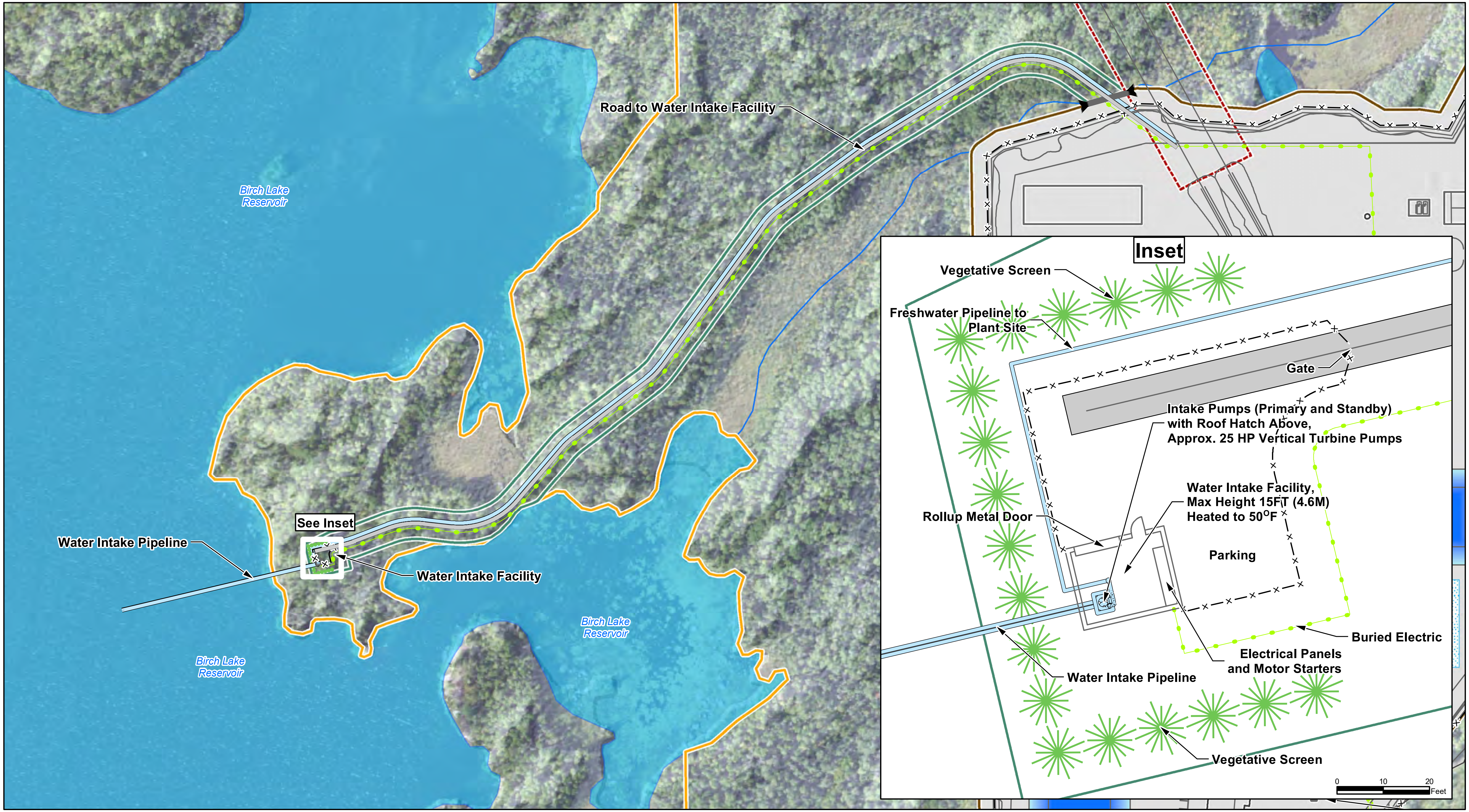


- COMPACTED CLEAN FILL
- CLEAN FILL PROTECTIVE COVER
- DRAINAGE COVER
- COMPACTED FILTERED TAILINGS
- ROAD GRAVEL SURFACE
- COMPACTED LOW PERMEABILITY SOIL
- GROUT CURTAIN
- SUITABLE FOUNDATION (PREPARED OVERBURDEN OR COMPACTED FILL)
- BEDROCK
- 60 mil LLDPE Geomembrane

TWIN METALS MINNESOTA




| TWIN METALS MINNESOTA | |
|---|---|
| **FIGURE 2-15**<br>TYPICAL DITCH SECTION | |
| SCALE: | DATE: SEPTEMBER 2019 |




**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**

- Facilities
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Water Intake Corridor

TWIN METALS MINNESOTA

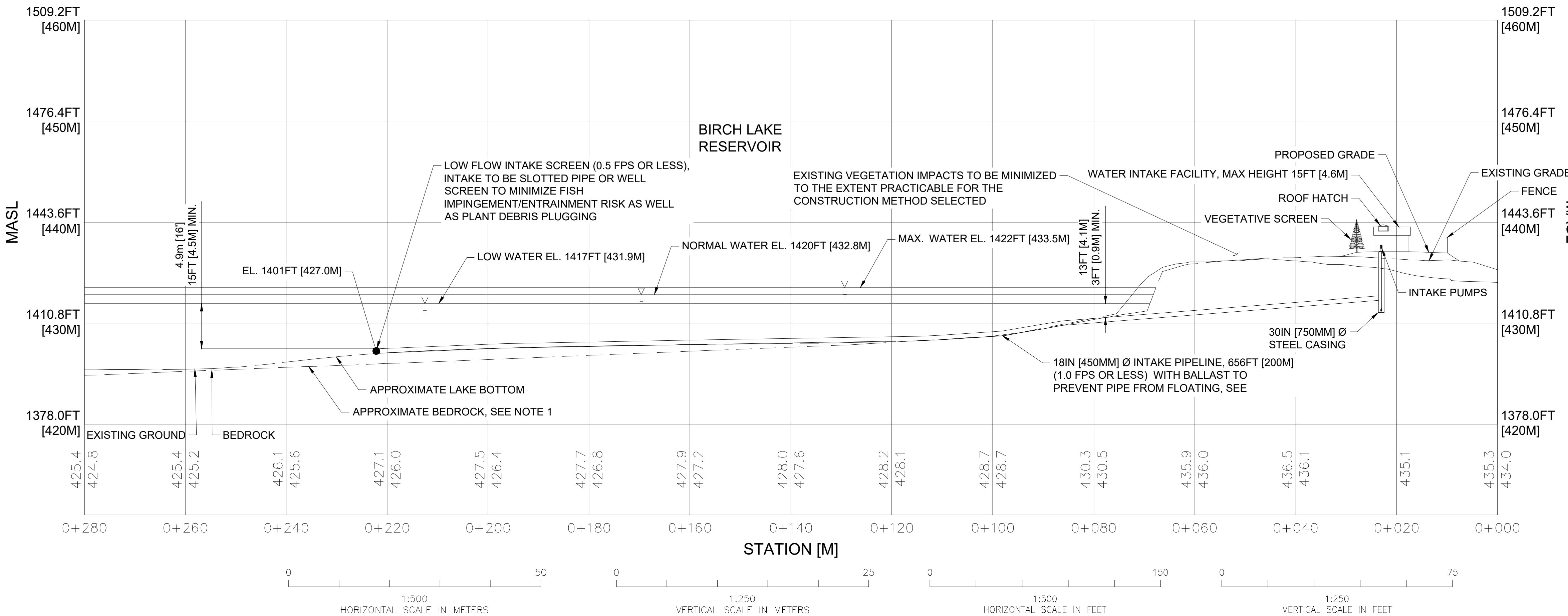
TWIN METALS MINNESOTA

**FIGURE 2-16**

WATER INTAKE FACILITY AND ACCESS ROAD PLAN AND GENERAL ARRANGEMENT

Scale: 0 150 300 Feet

Date: SEPTEMBER 2019




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

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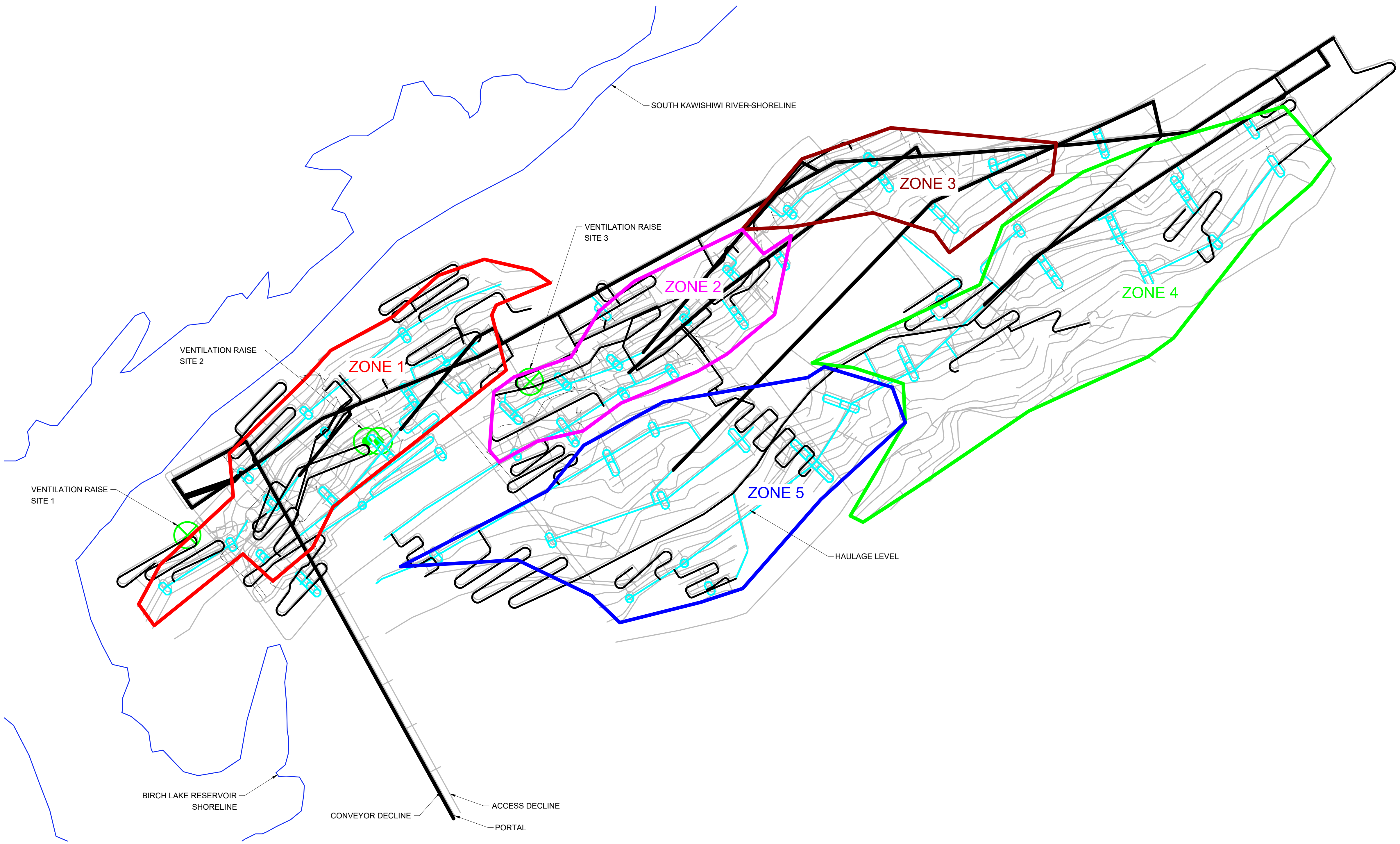
| TWIN METALS MINNESOTA | |
|---|---|
| **FIGURE 2-17**<br>WATER INTAKE FACILITY<br>PLAN, PROFILE, SECTIONS AND DETAILS | |
| SCALE: 0 187.5 375 750 FEET | DATE: AUGUST 2019 |


TWIN METALS MINNESOTA

**FIGURE 2-18**

MINE PLAN BY
LEASE OWNER TYPE

| | |
|---|---|
| Scale: Not to Scale | Date: 09/24/2019 |




UNDERGROUND MINE DESIGN - PLAN VIEW

LEGEND

- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY
- ZONE 3 BOUNDARY
- ZONE 4 BOUNDARY
- ZONE 5 BOUNDARY
- MINE RAMP
- HAULAGE LEVEL
- CONVEYOR DRIFT
- DRIFT
- INTAKE RAISE
- EXHAUST RAISE

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**FIGURE 2-19**

UNDERGROUND MINE DESIGN - STAGES MINE DESIGN - PLAN VIEW

| | |
|---|---|
| SCALE: 0 457200 FEET | DATE: SEPTEMBER 2019 |


## LEGEND

- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY
- ZONE 3 BOUNDARY
- ZONE 4 BOUNDARY
- ZONE 5 BOUNDARY
- MINE RAMP
- HAULAGE LEVEL
- CONVEYOR DRIFT
- DRIFT

N

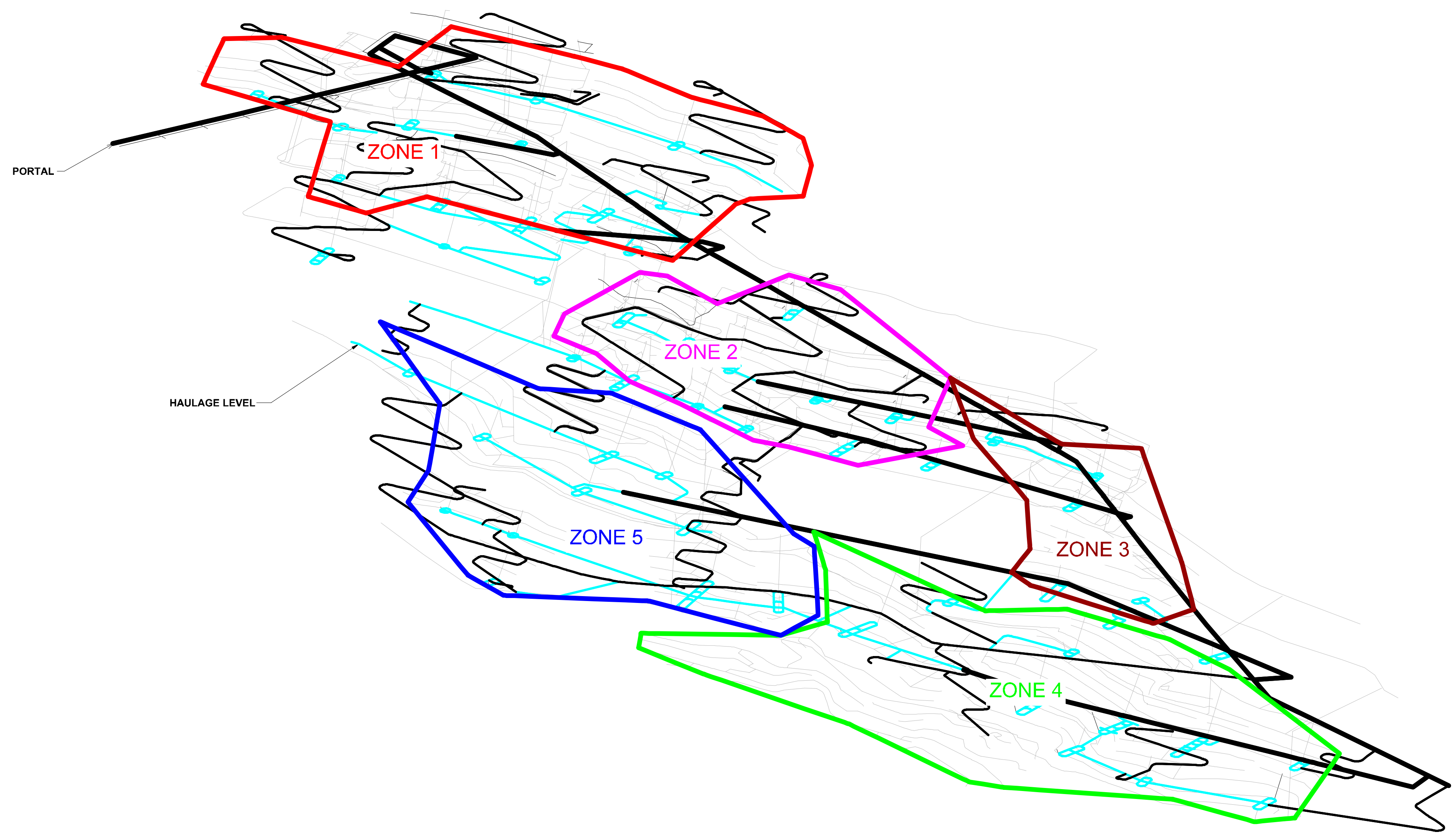
TWIN METALS MINNESOTA

**FIGURE 2-20**

UNDERGROUND MINE DESIGN - STAGES FRONT VIEW - SECTION A

SCALE: 0 457200 FEET

DATE: SEPTEMBER 2019




LEGEND

- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY
- ZONE 3 BOUNDARY
- ZONE 4 BOUNDARY
- ZONE 5 BOUNDARY
- MINE RAMP
- HAULAGE LEVEL
- CONVEYOR DRIFT
- DRIFT

TWIN METALS MINNESOTA

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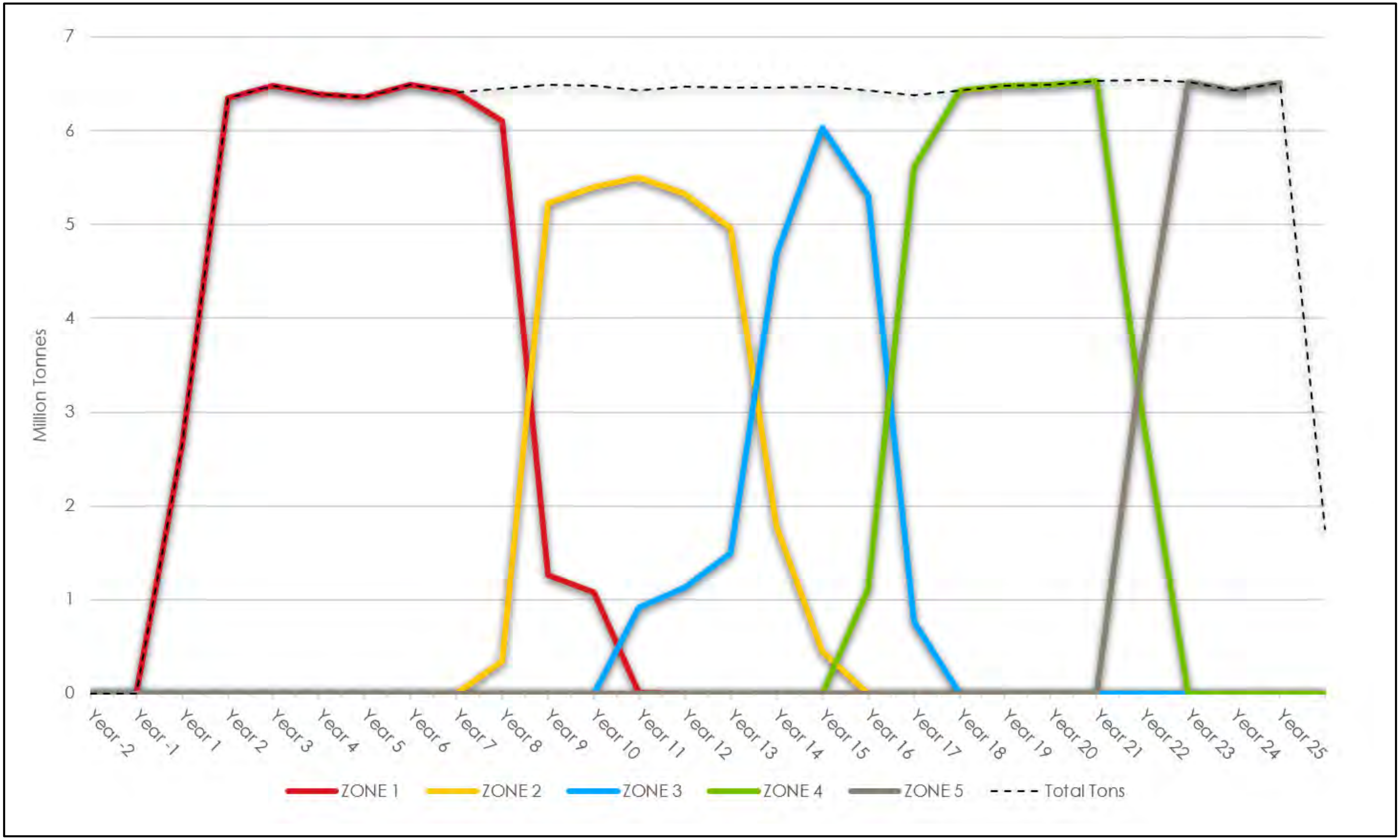
TWIN METALS MINNESOTA

**FIGURE 2-21**

UNDERGROUND MINE
DESIGN - STAGES ISO VIEW

SCALE: 0 457200 FEET

DATE: SEPTEMBER 2019

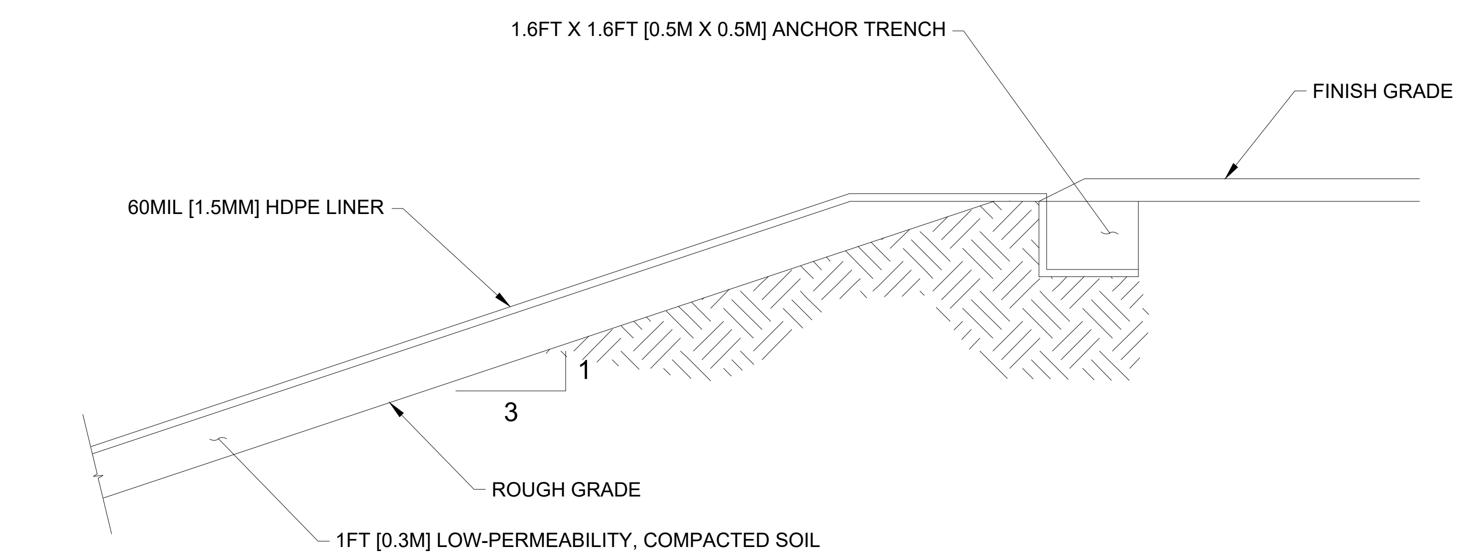



TWIN METALS MINNESOTA

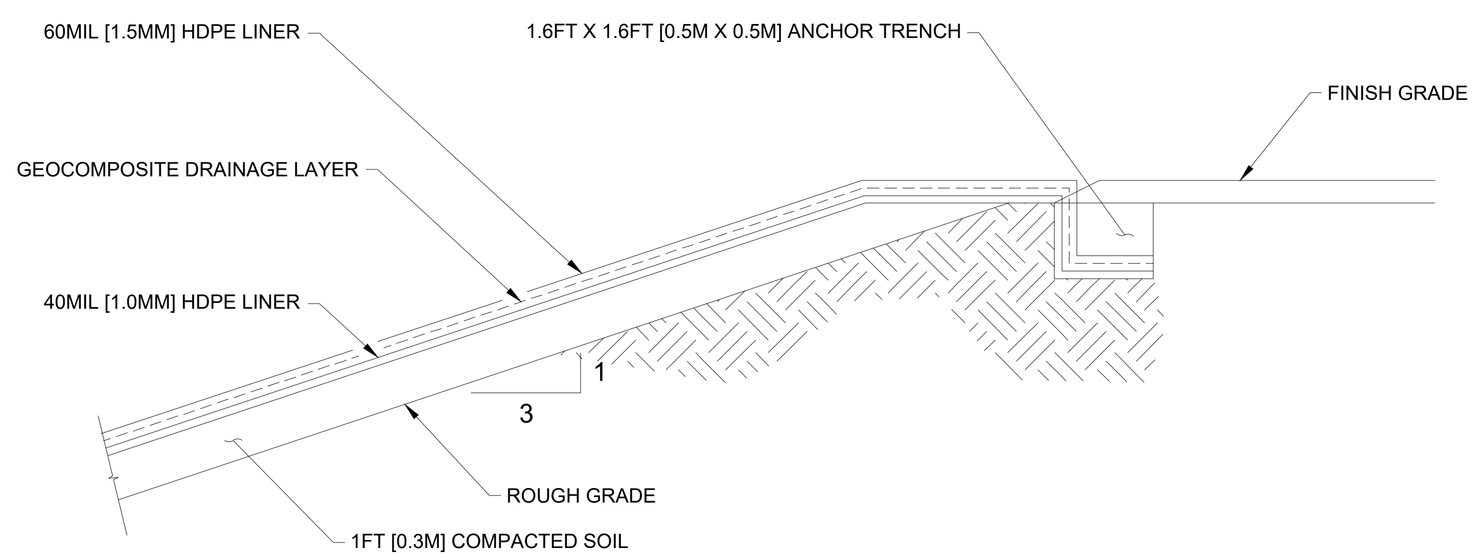
**FIGURE 2-22**

MINE PRODUCTION BY
ZONE OVER TIME

| Scale: Not to Scale | Date: 09/24/2019 |
|---|---|




TYPICAL CONTACT WATER POND LINER




TYPICAL PROCESS WATER POND LINER

NOTES:

1. THIS DRAWING SHOWS LINER REQUIREMENTS FOR THE CONTACT AND PROCESS WATER PONDS. CIVIL, MECHANICAL, AND PIPING ARE NOT SHOWN.

TWIN METALS MINNESOTA

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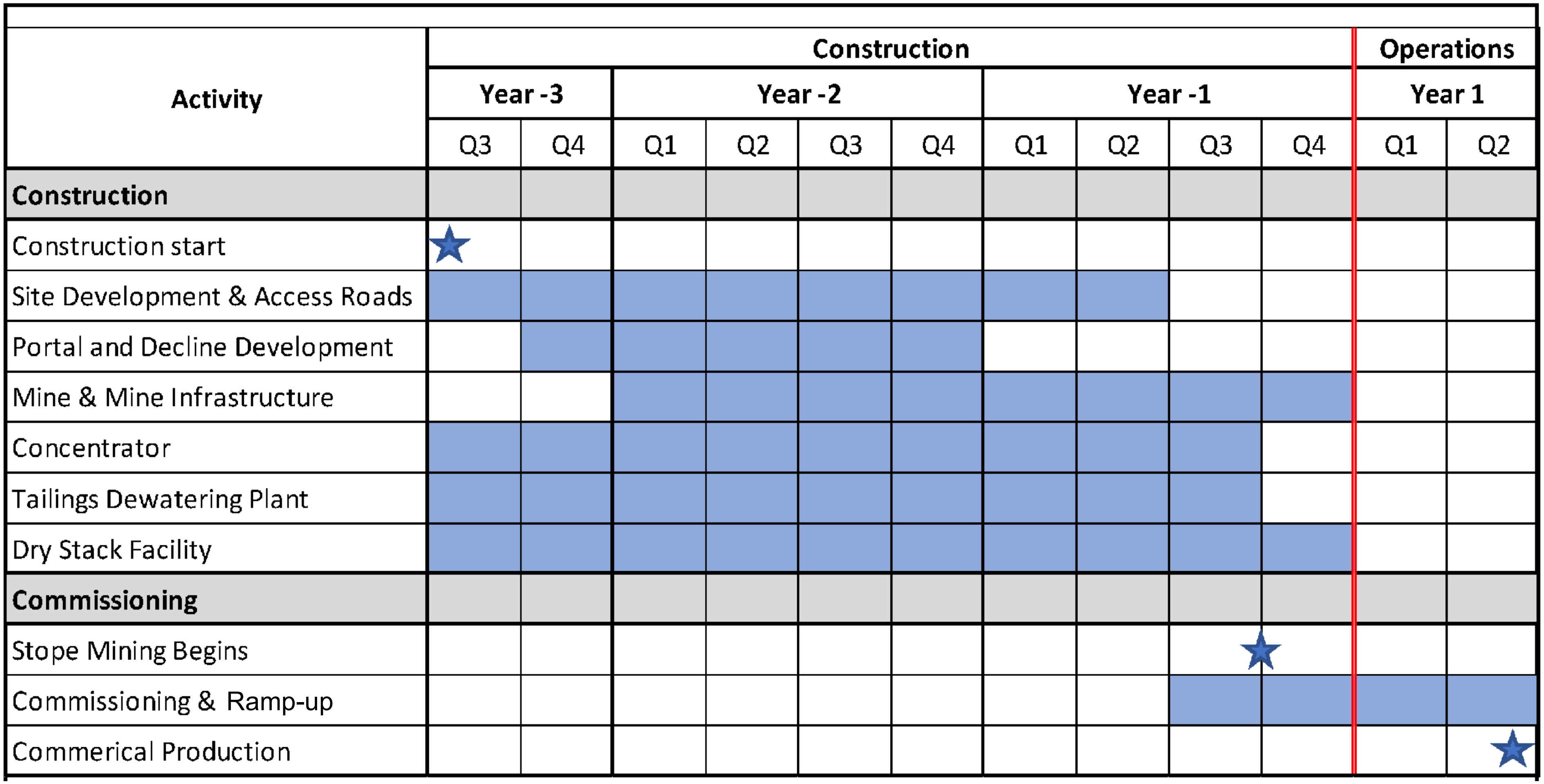
| TWIN METALS MINNESOTA | |
|---|---|
| **FIGURE 2- 23**<br>PLANT SITE OPERATIONS SITE PONDS SECTIONS | |
| SCALE: | DATE: SEPTEMBER 2019 |




TWIN METALS MINNESOTA

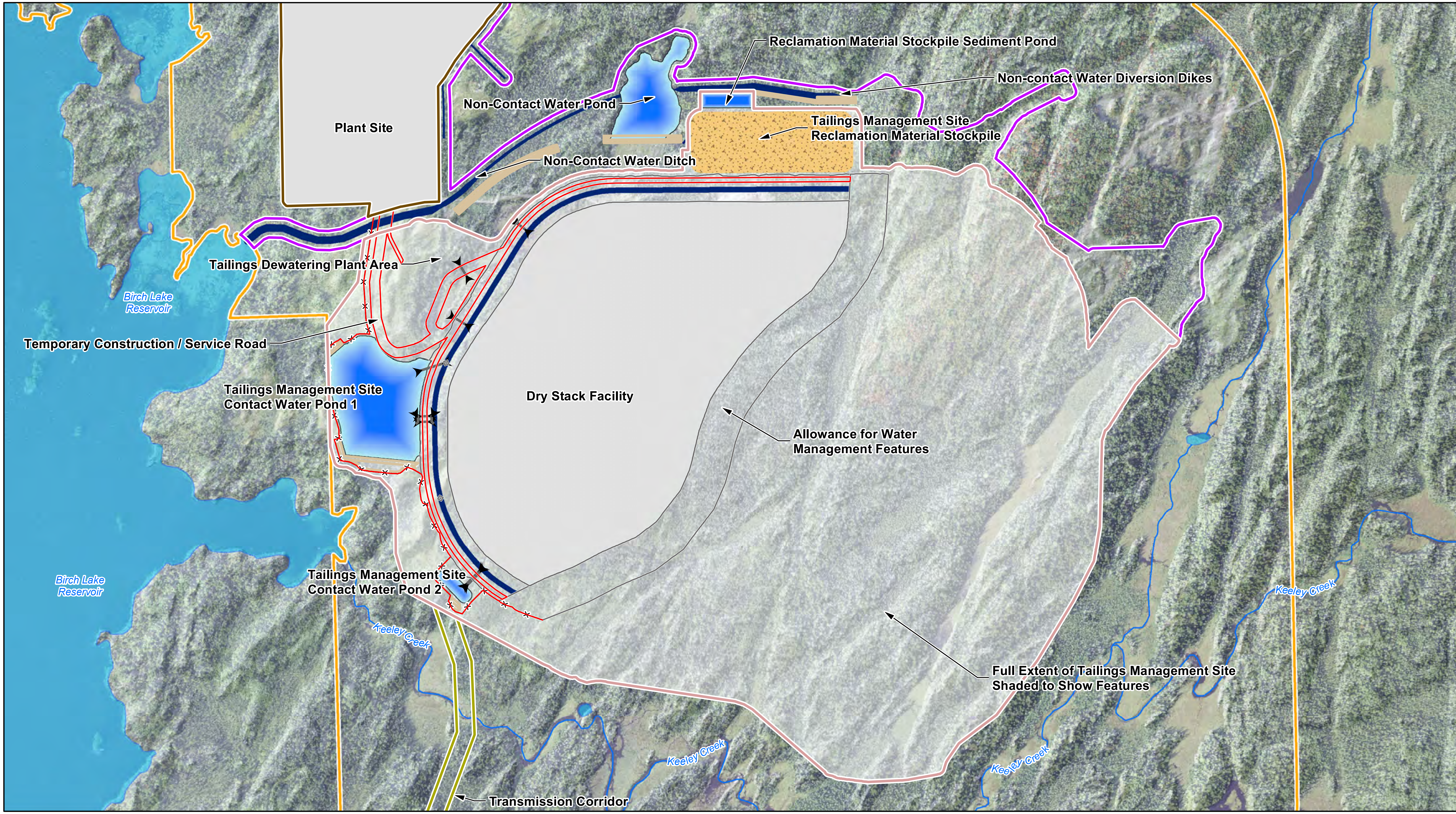
TWIN METALS MINNESOTA

**FIGURE 2-24**

PROJECT CONSTRUCTION SCHEDULE

Scale: Not to Scale

Date: 09/19/2019




**NOTES:**

1. Base air photo from the USDA Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from MDNR.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- Temporary Facilities
- Dike; Berm; Embankment
- Facilities
- Culvert
- Fence
- River/Stream
- Lake/Pond
- Project Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor

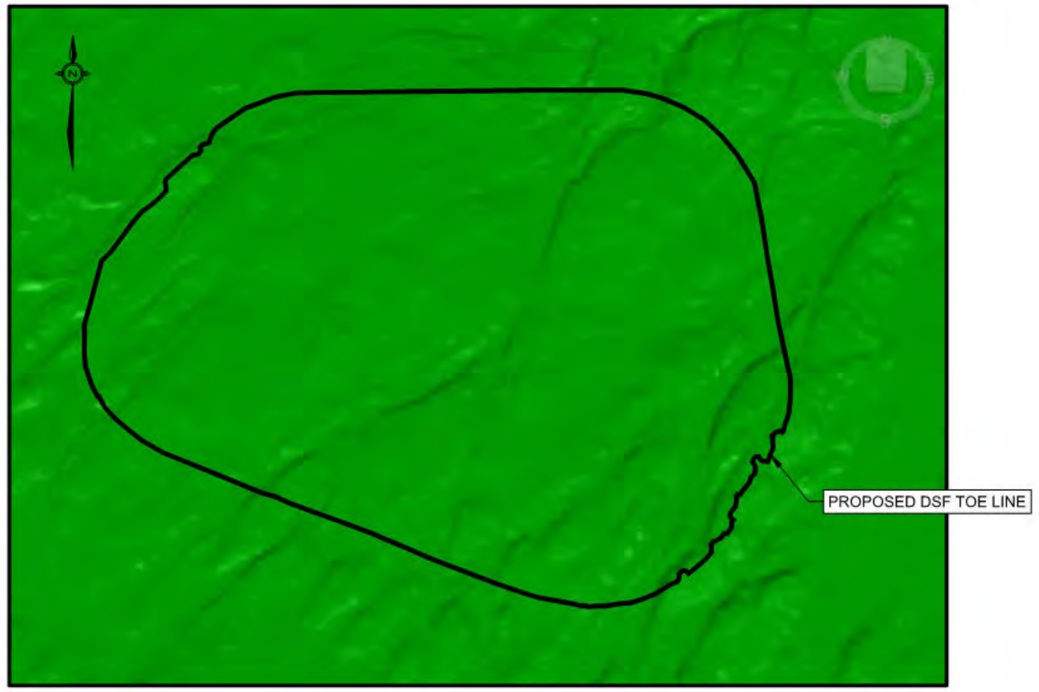
TWIN METALS MINNESOTA

**FIGURE 2-25**

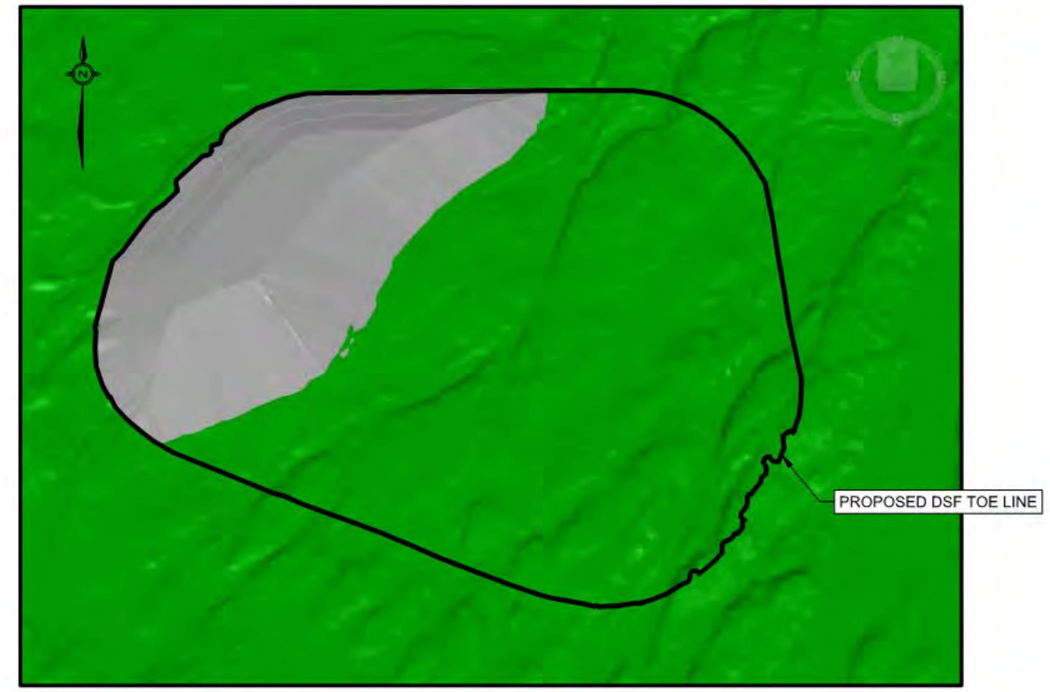
TAILINGS MANAGEMENT SITE
CONSTRUCTION PHASE

Scale: 0 400 800 Feet

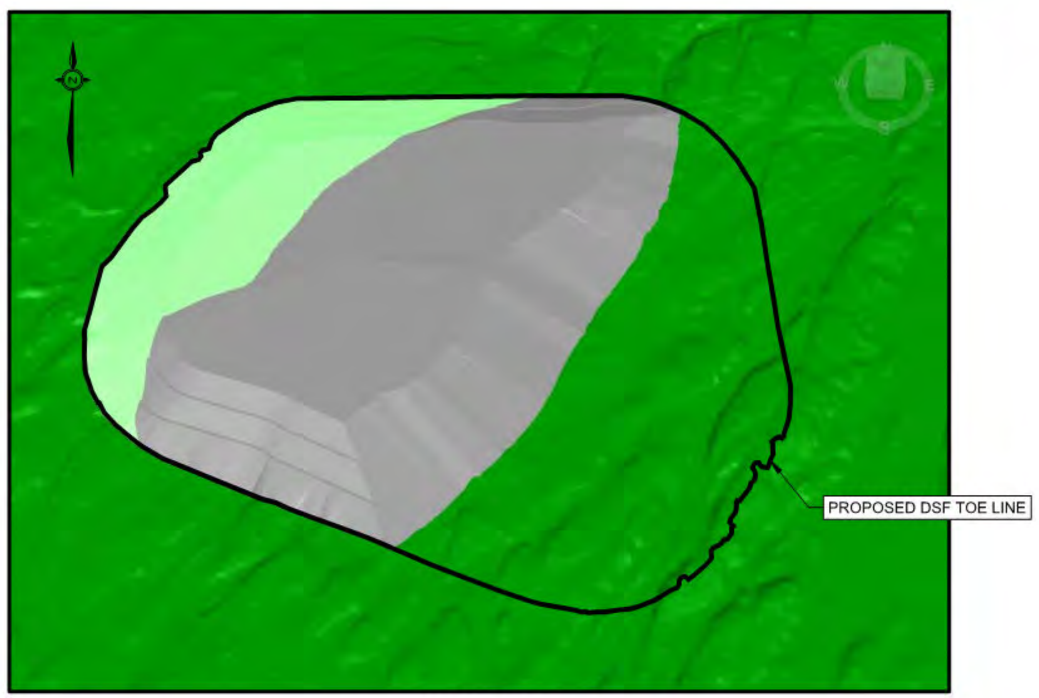
Date: SEPTEMBER 2019




ORIGINAL GROUND (PRIOR TO CONSTRUCTION)
N.T.S.




STAGE 1
(APPROXIMATELY YEAR 6 OF OPERATION)
N.T.S.




STAGE 2
(APPROXIMATELY YEAR 16 OF OPERATION)
N.T.S.


STAGE 3
(APPROXIMATELY YEAR 25 OF OPERATION)
N.T.S.

NOT FOR CONSTRUCTION

**NOTES:**
1. DSF - Dry Stack Facility

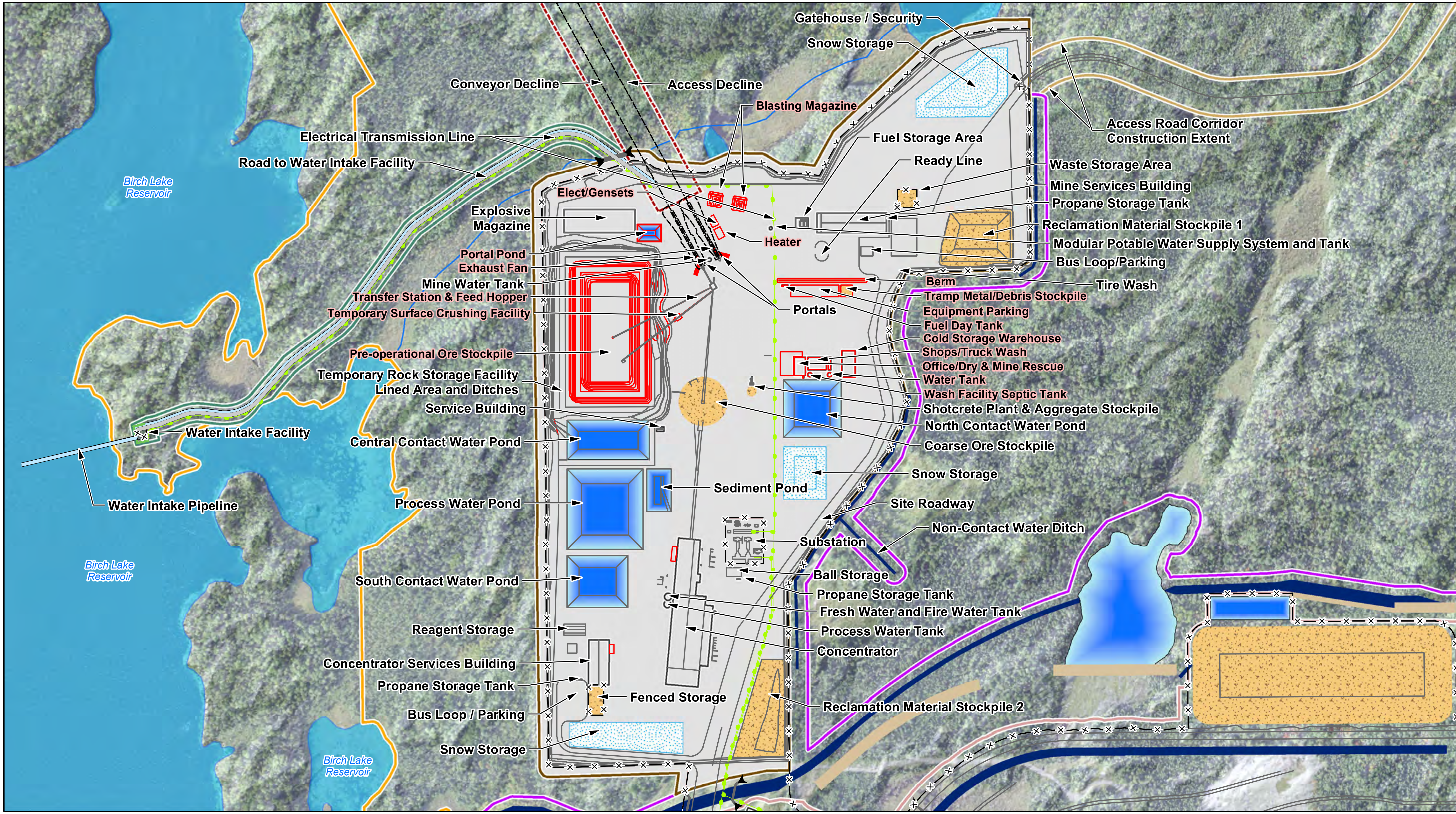
TWIN METALS MINNESOTA

TWIN METALS MINNESOTA

**FIGURE 2-26**

DRY STACK FACILITY CONSTRUCTION STAGES

| Scale: NOT TO SCALE | Date: SEPTEMBER 2019 |
|---|---|




**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**

- Facility
- Decline
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- Temporary Facilities during Construction
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Water Intake Corridor
- Access Road Corridor

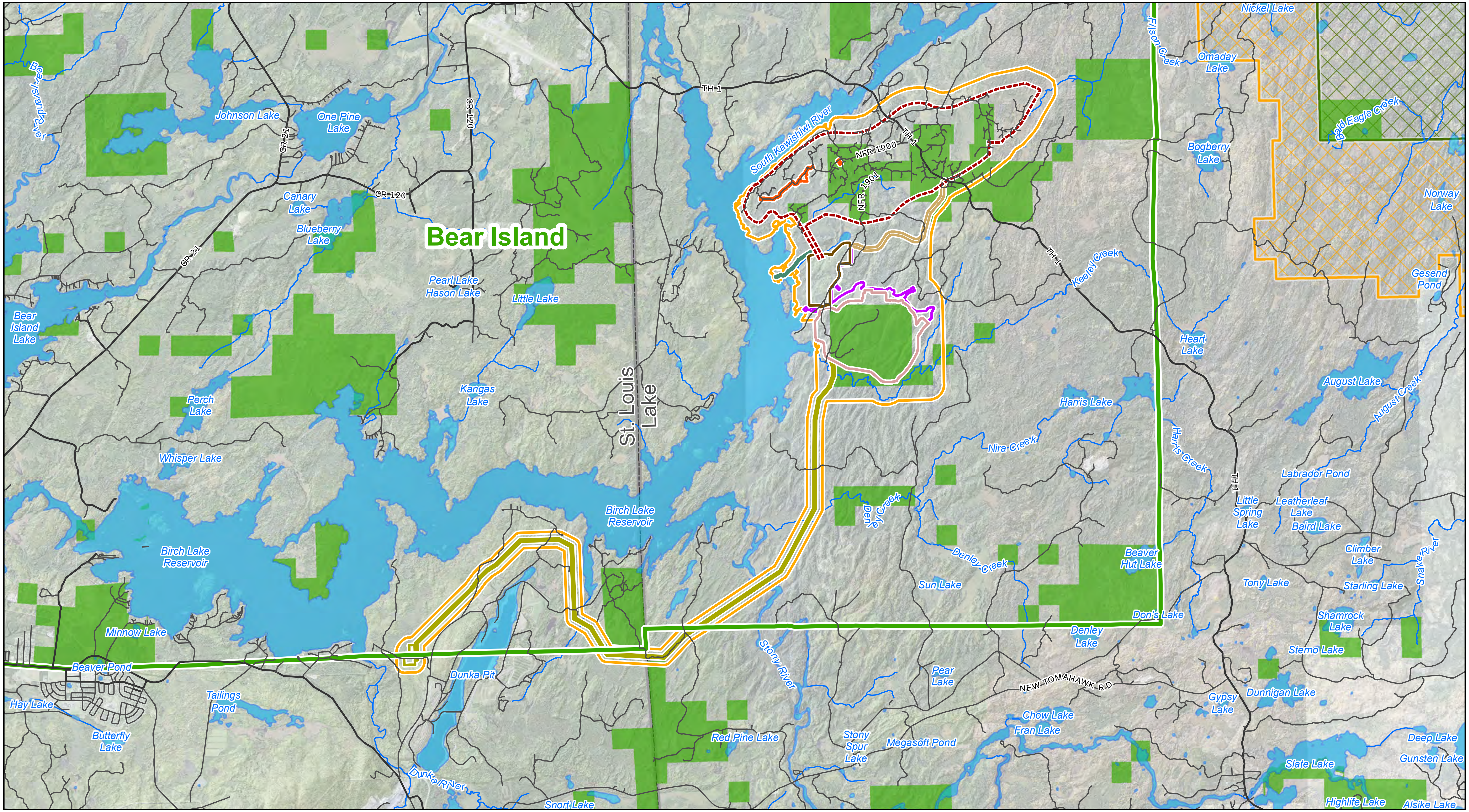
TWIN METALS MINNESOTA

**FIGURE 2-27**

PLANT SITE CONSTRUCTION PHASE

Scale: 0 250 500 Feet

Date: SEPTEMBER 2019




**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. Boundary Waters Canoe Area Wilderness, Mineral Management Corridor and State Forest data from Minnesota Department of Natural Resources.

**LEGEND**

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Municipal Boundary
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Boundary Waters Canoe Area Wilderness Mineral Management Corridor
- State Forests - Statutory Boundaries
- State Forests - Management Units
- 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

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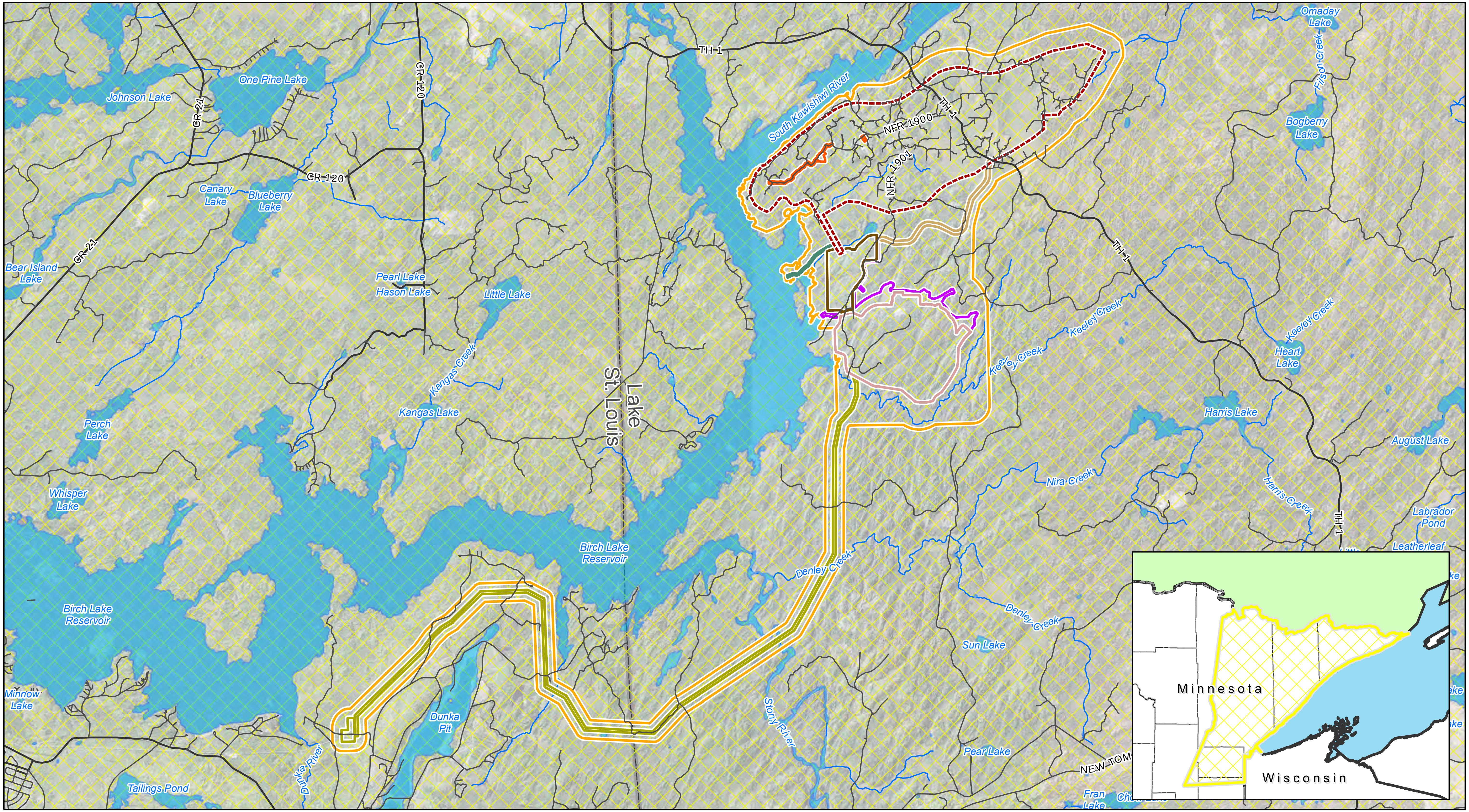
TWIN METALS MINNESOTA

**FIGURE 3-1**

BWCAW MINERALS MANAGEMENT CORRIDOR AND MDNR STATE FOREST MANAGEMENT UNITS

Scale: 0 3,000 6,000 Feet

Date: SEPTEMBER 2019




**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

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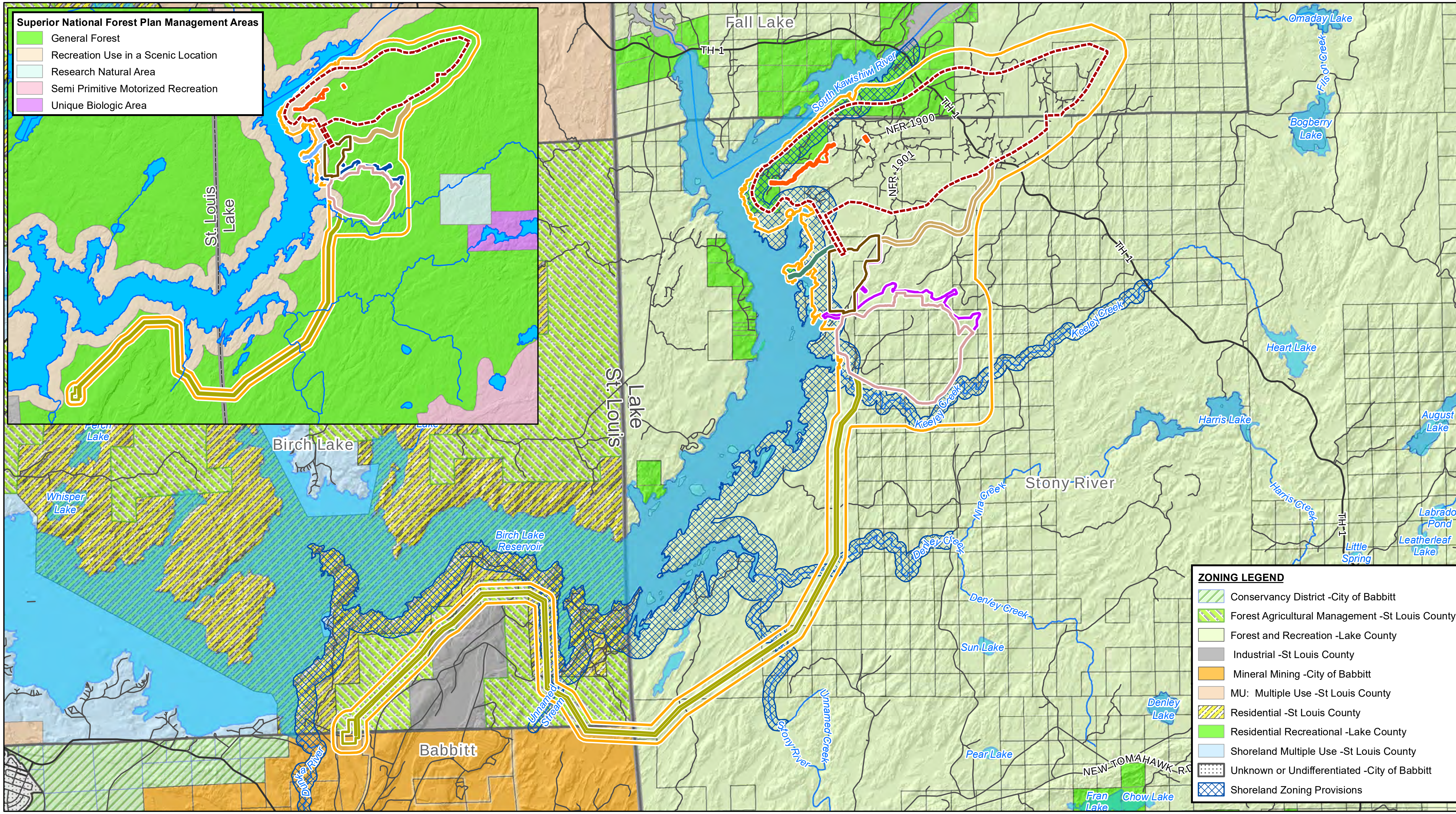
TWIN METALS MINNESOTA

**FIGURE 3-2**

1854 TREATY CEDED TERRITORY

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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).

**LEGEND**

- Primary Road
- Secondary Road
- Public Waters - Watercourse Delineation
- Public Waters - Basin Delineation
- Municipal Boundary
- 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

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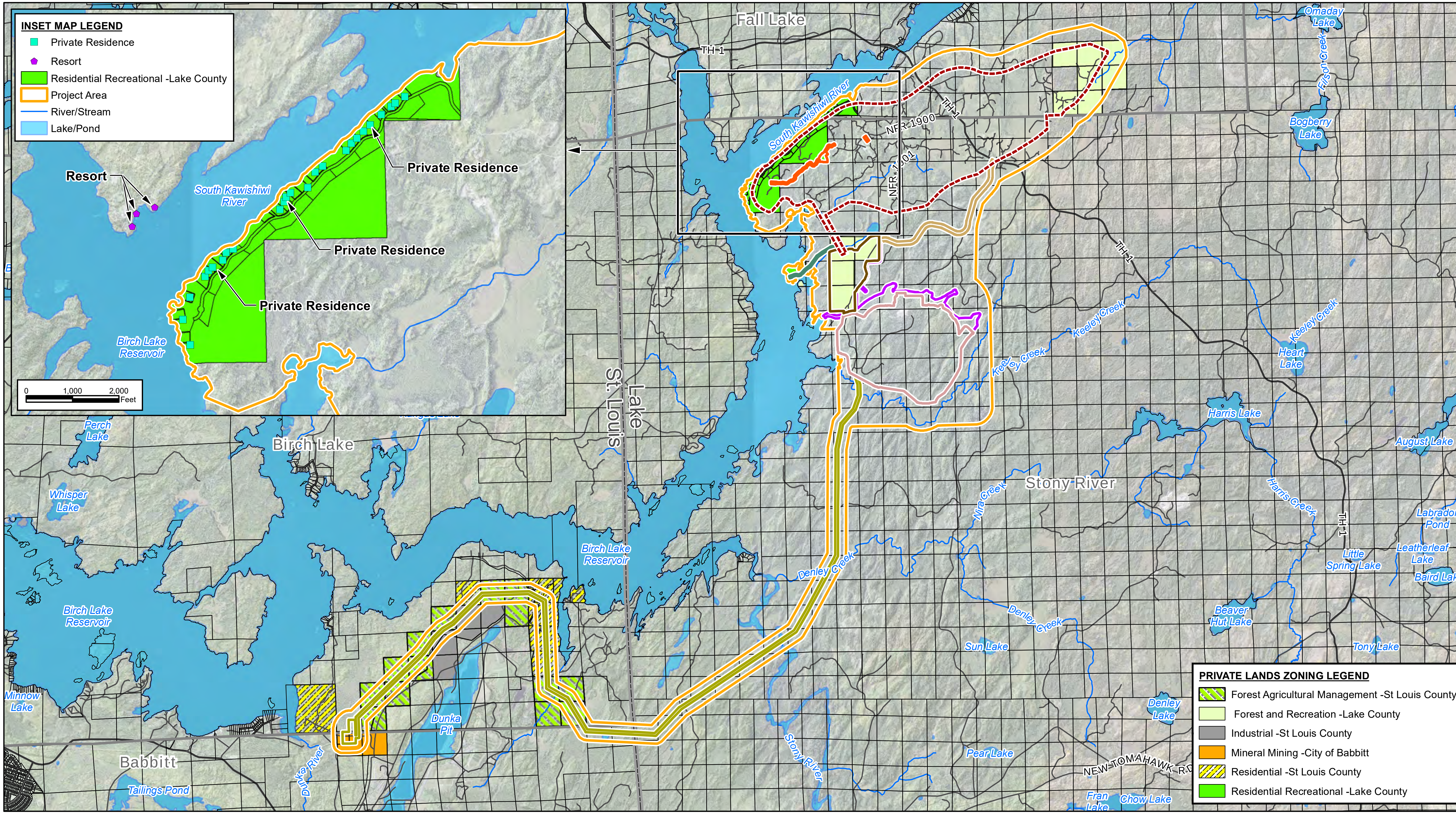
Scale: 0 2,500 5,000 Feet

TWIN METALS MINNESOTA

**FIGURE 3-3**

ZONING AND LAND USE MAP

Date: SEPTEMBER 2019




**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).

**LEGEND**

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Property Boundary
- Municipal Boundary
- 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

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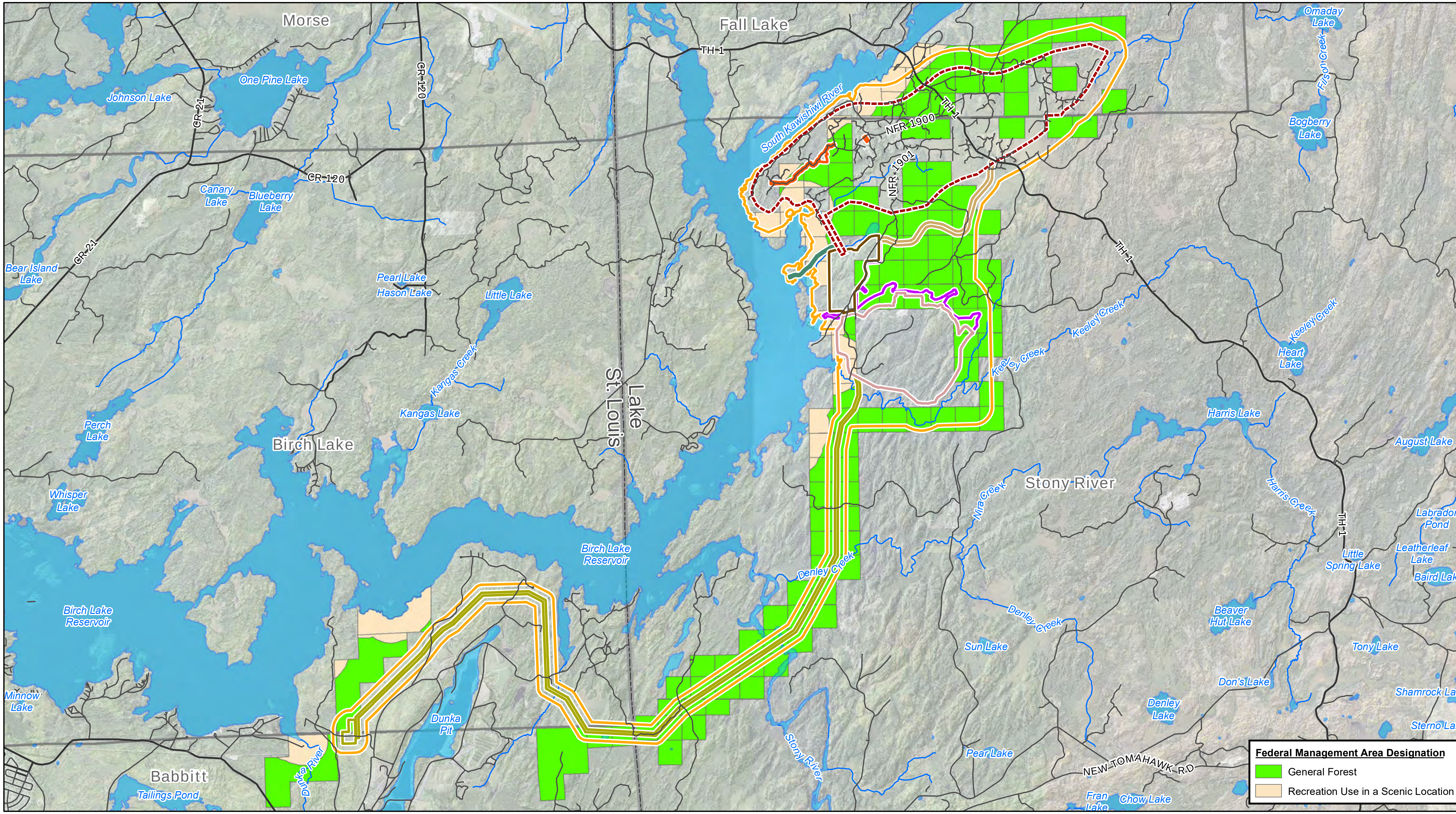
TWIN METALS MINNESOTA

**FIGURE 3-4**

PRIVATE LANDS ZONING

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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).

**LEGEND**

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Municipal Boundary
- 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

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TWIN METALS MINNESOTA

**FIGURE 3-5**

FEDERAL LAND USE

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

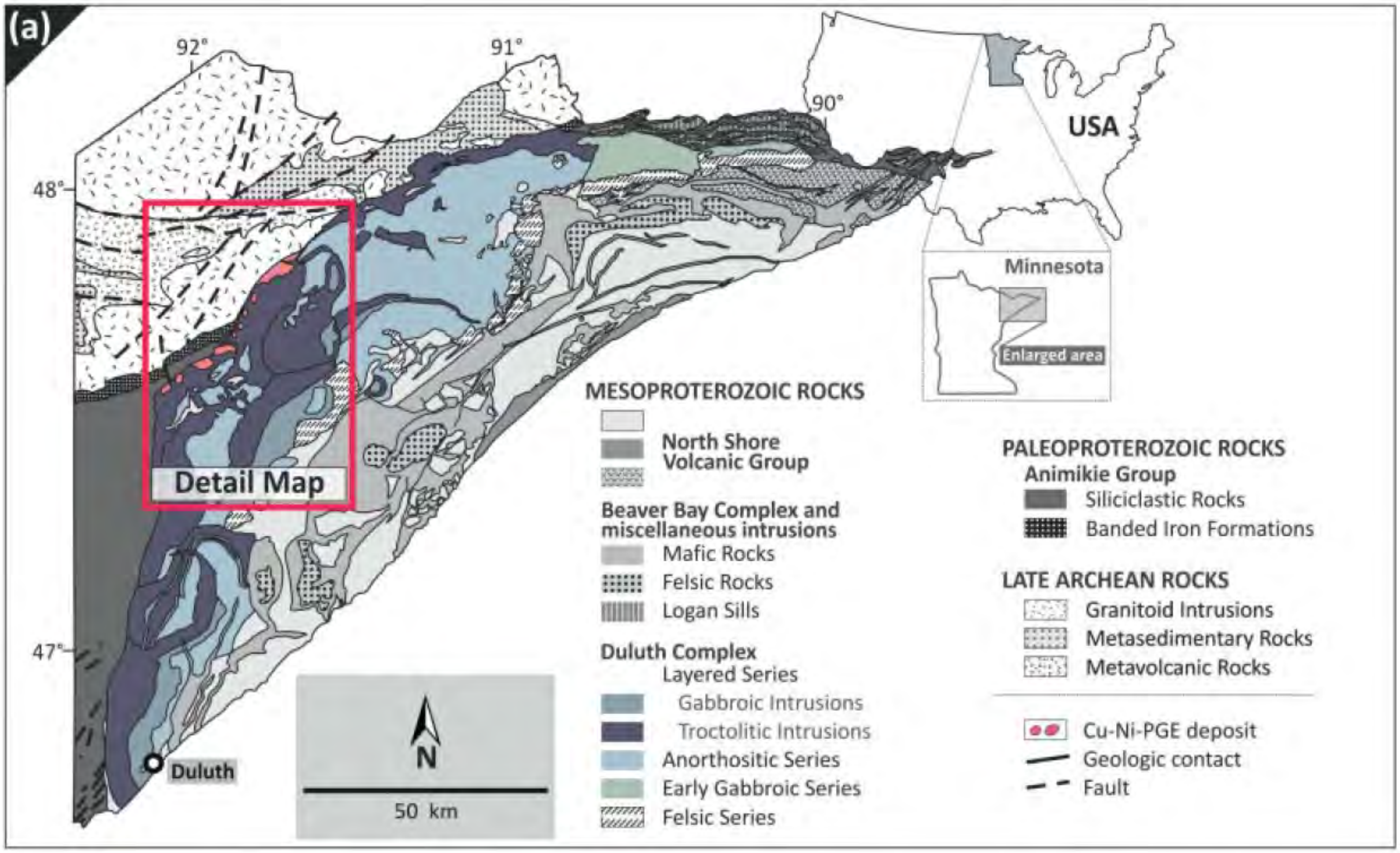
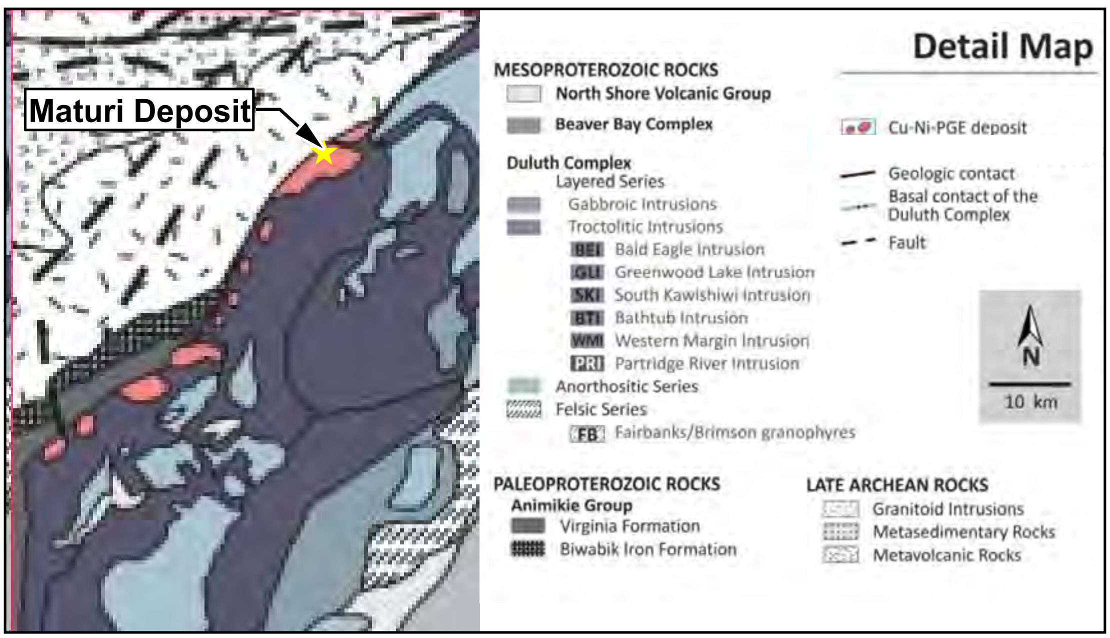



FIG 1. (a) Geologic map of northeastern Minnesota (modified from Miller *et al.* 2001) showing footwall units (Paleoproterozoic and Neoarchean rocks) and the Duluth Complex with its Felsic, Early Gabbroic, Anorthositic, and Layered Series and hanging wall units, which comprise basaltic rocks from the North Shore Volcanic Group.




**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

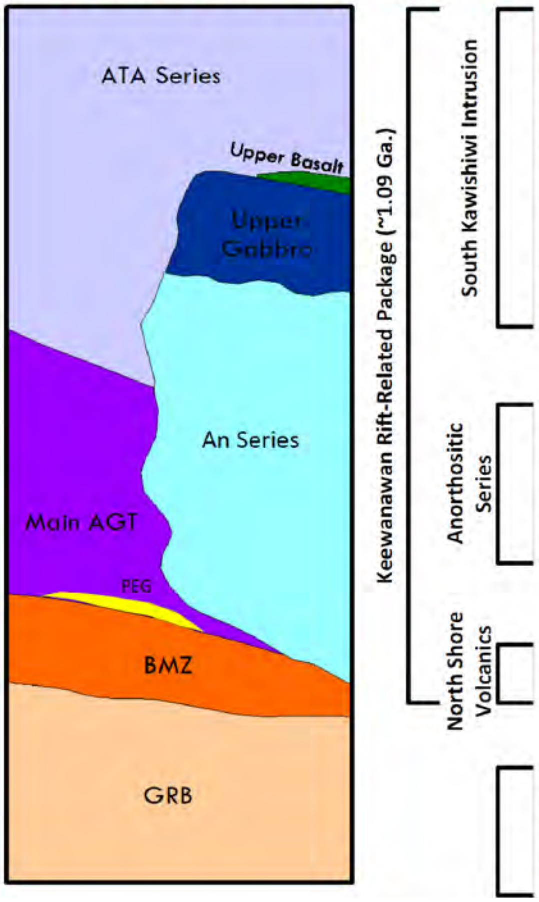
TWIN METALS MINNESOTA

**FIGURE 3-6**

GEOLOGY OF THE DULUTH COMPLEX

| | |
|---|---|
| Scale: AS SHOWN | Date: SEPTEMBER 2019 |

# Generalized Stratigraphy of the Maturi Deposit




ATA Series: Thick upper aspect of the SKI dominated by medium-grained intergranular anorthositic troctolite and troctolitic anorthosite. Commonly weakly to moderately foliated.

Main AGT: Thick homogenous package of medium-grained ophitic augite troctolite. Interpreted to be the liquid phase of the SKI.

PEG: Pegmatoidal to coarse-grained anorthositic troctolite to anorthositic gabbro. Largely barren.

BMZ (Basal Mineralized Zone): Heterogeneous package of mineralized dominantly troctolitic rocks consisting of the UH, S3, S2, and S1 subunits.

Upper Gabbro: Upper mafic phase of the Anorthositic Series. Typified by coarse-grained oxide olivine gabbro to anorthositic gabbro.

An Series: Lower feldspathic aspect of the Anorthositic Series typified by foliated very coarse-grained anorthosite to medium-grained ophitic gabbroic anorthosite or anorthositic gabbro.

Upper Basalt: Tholeitic basalt inclusion of the extrusive phase of the Mid-Continent Rift.

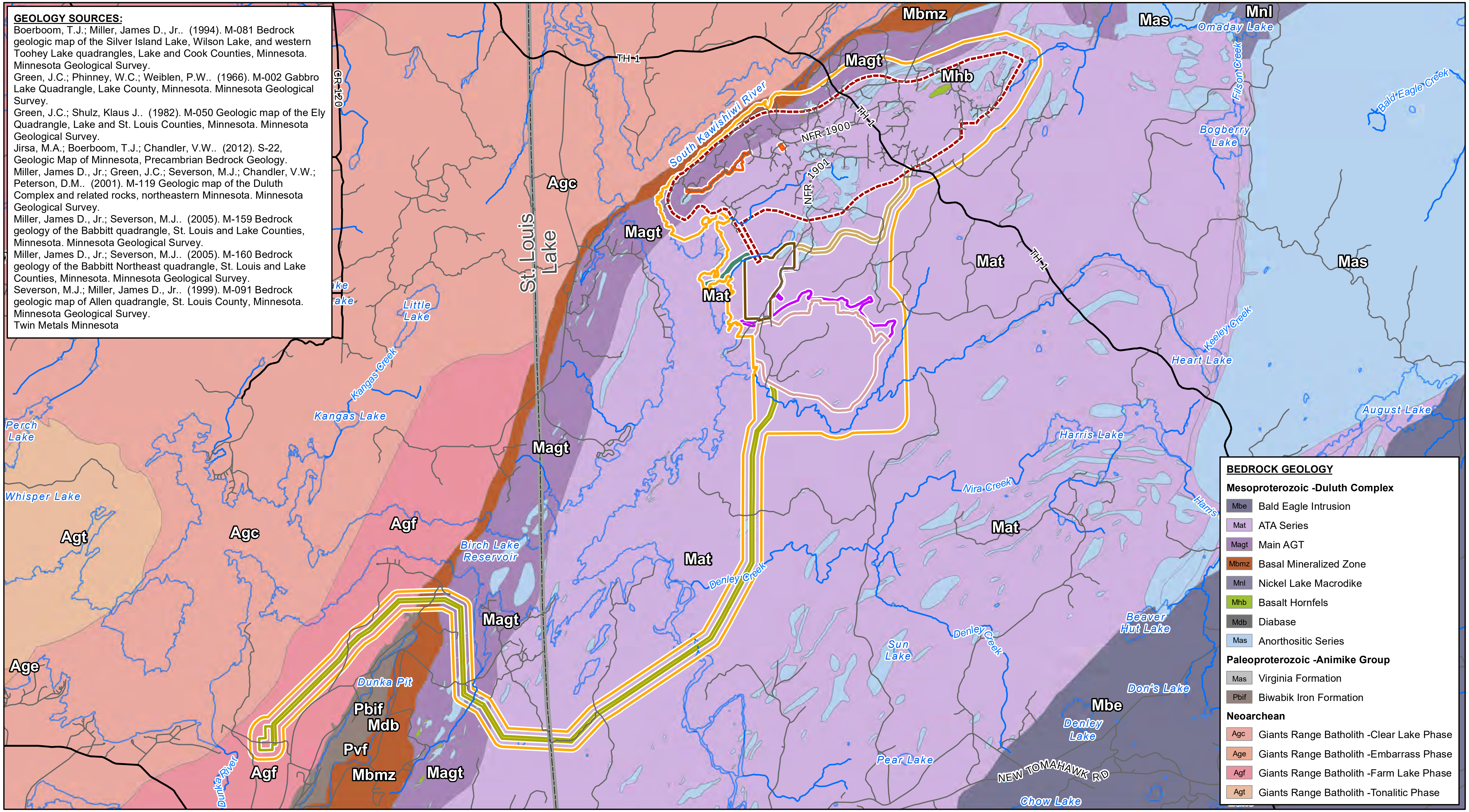
GRB (Giants Range Batholith): Heterogeneous Archean (~2.68 Ga) granitoid batholith. Dominant lithologies of porphyritic quartz monzonite to diorite. Locally exhibits sulfide mineralization near the contact with and within the contact metamorphic aureole of the SKI.

TWIN METALS MINNESOTA

**FIGURE 3-7**

MATURI DEPOSIT STRATIGRAPHY

| | |
|---|---|
| Scale: NOT TO SCALE | Date: SEPTEMBER 2019 |




**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).

**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

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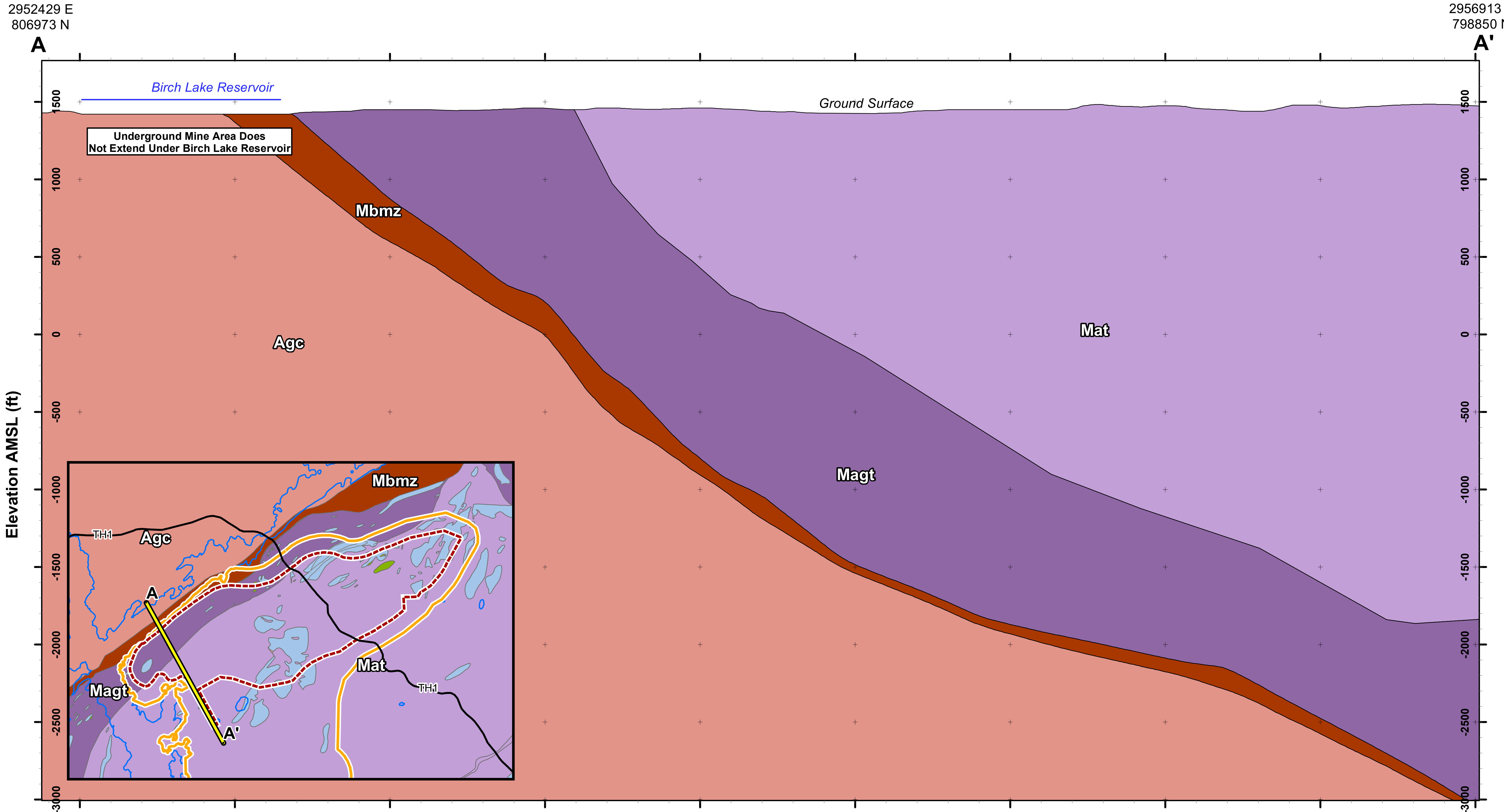
Scale: 0 2,500 5,000 Feet

TWIN METALS MINNESOTA

**FIGURE 3-8**

REGIONAL BEDROCK GEOLOGY

Date: SEPTEMBER 2019




**NOTES:**

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
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. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

**LEGEND**

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

**Geologic Unit**

- Magt Main Augite troctolite
- Mat Anorthositic troctolite to troctolitic anorthosite
- Mbmz Basal Mineralized Zone
- Agc Giants Range Batholith

TWIN METALS MINNESOTA

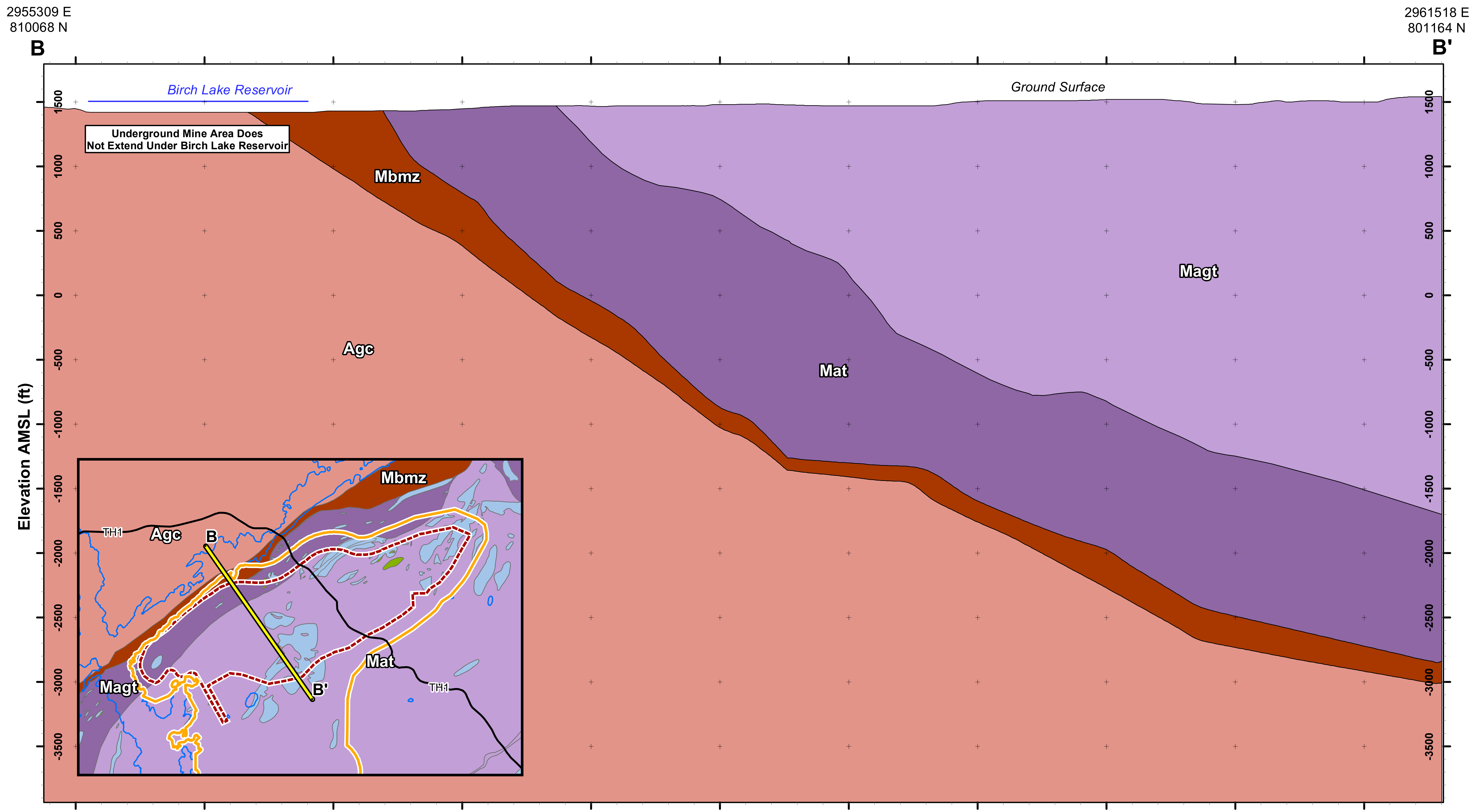
TWIN METALS MINNESOTA

**FIGURE 3-9**

BEDROCK CROSS SECTION A-A'
UNDERGROUND MINE AREA

Horizontal & Vertical Scale: 0 250 500 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
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. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

**LEGEND**

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

**Geologic Unit**

| | |
|---|---|
| Magt | Main Augite troctolite |
| Mat | Anorthositic troctolite to troctolitic anorthosite |
| Mbmz | Basal Mineralized Zone |
| Agc | Giants Range Batholith |

TWIN METALS MINNESOTA

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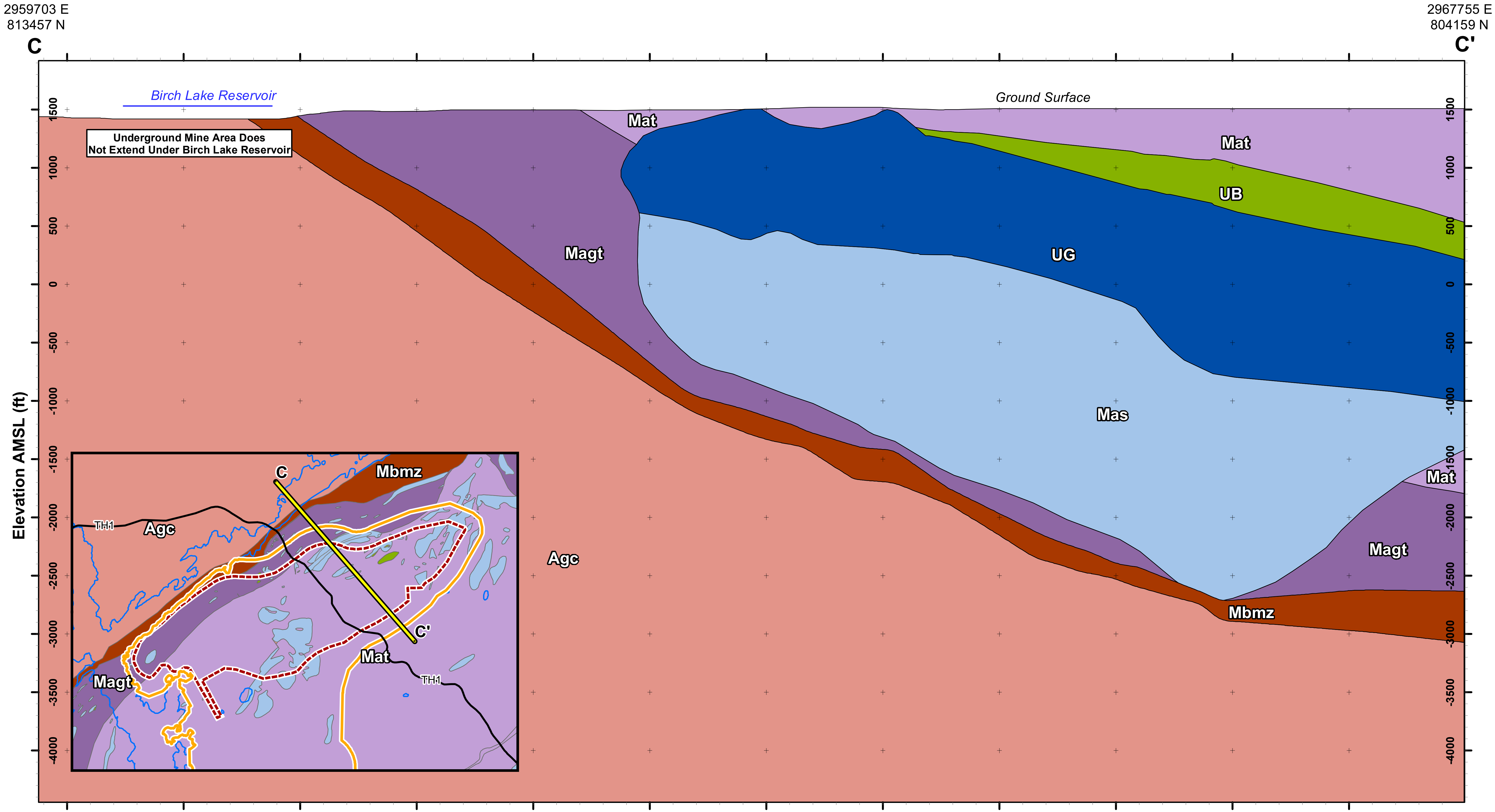
TWIN METALS MINNESOTA

**FIGURE 3-10**

BEDROCK CROSS SECTION B-B'
UNDERGROUND MINE

Horizontal & Vertical Scale: 0 250 500 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
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. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

**LEGEND**

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

**Geologic Unit**

- Magt — Main Augite troctolite
- Mat — Anorthositic troctolite to troctolitic anorthosite
- Mbmz — Basal Mineralized Zone
- UG — Upper Gabbro
- Mas — Anorthositic Series
- UB — Upper Basalt
- Agc — Giants Range Batholith

TWIN METALS MINNESOTA

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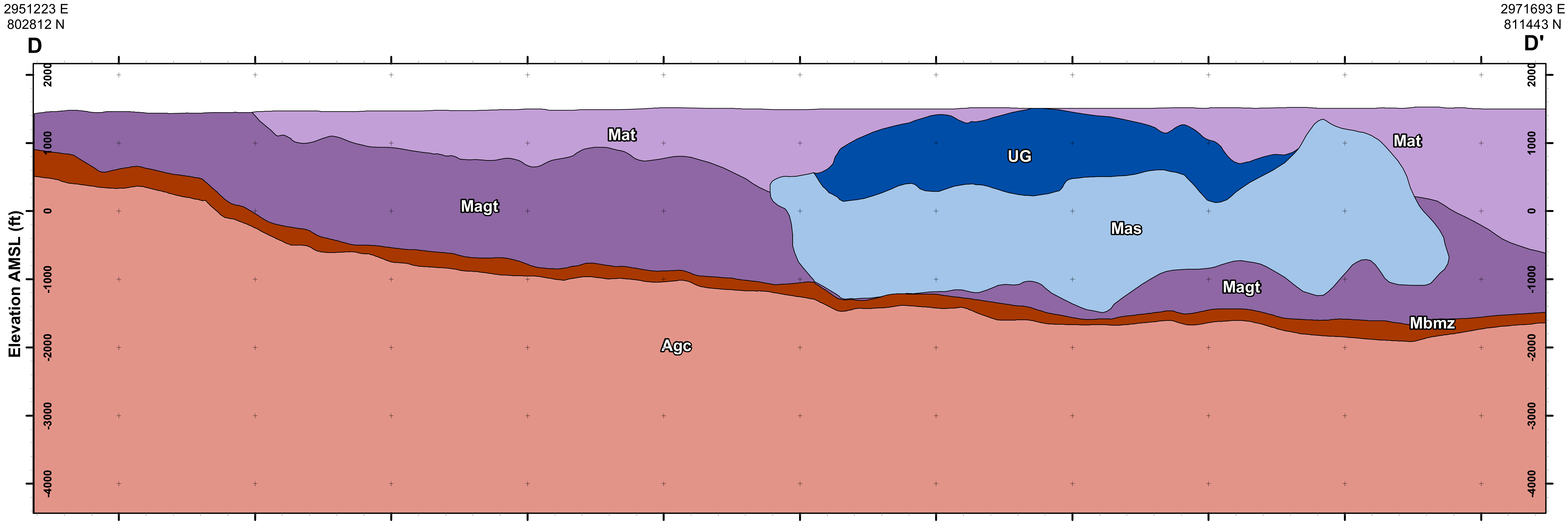
TWIN METALS MINNESOTA

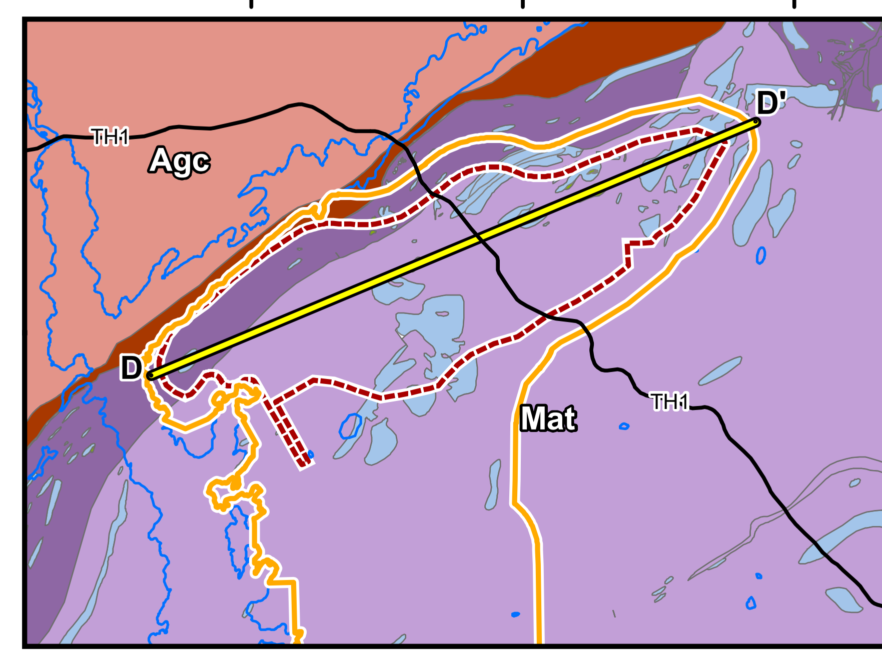
**FIGURE 3-11**

BEDROCK CROSS SECTION C-C'
UNDERGROUND MINE

Horizontal & Vertical Scale: 0 250 500 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
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. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

**LEGEND**

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

**Geologic Unit**

- Magt — Main Augite troctolite
- Mat — Anorthositic troctolite to troctolitic anorthosite
- Mbmz — Basal Mineralized Zone
- UG — Upper Gabbro
- Mas — Anorthositic Series
- Agc — Giants Range Batholith

TWIN METALS MINNESOTA

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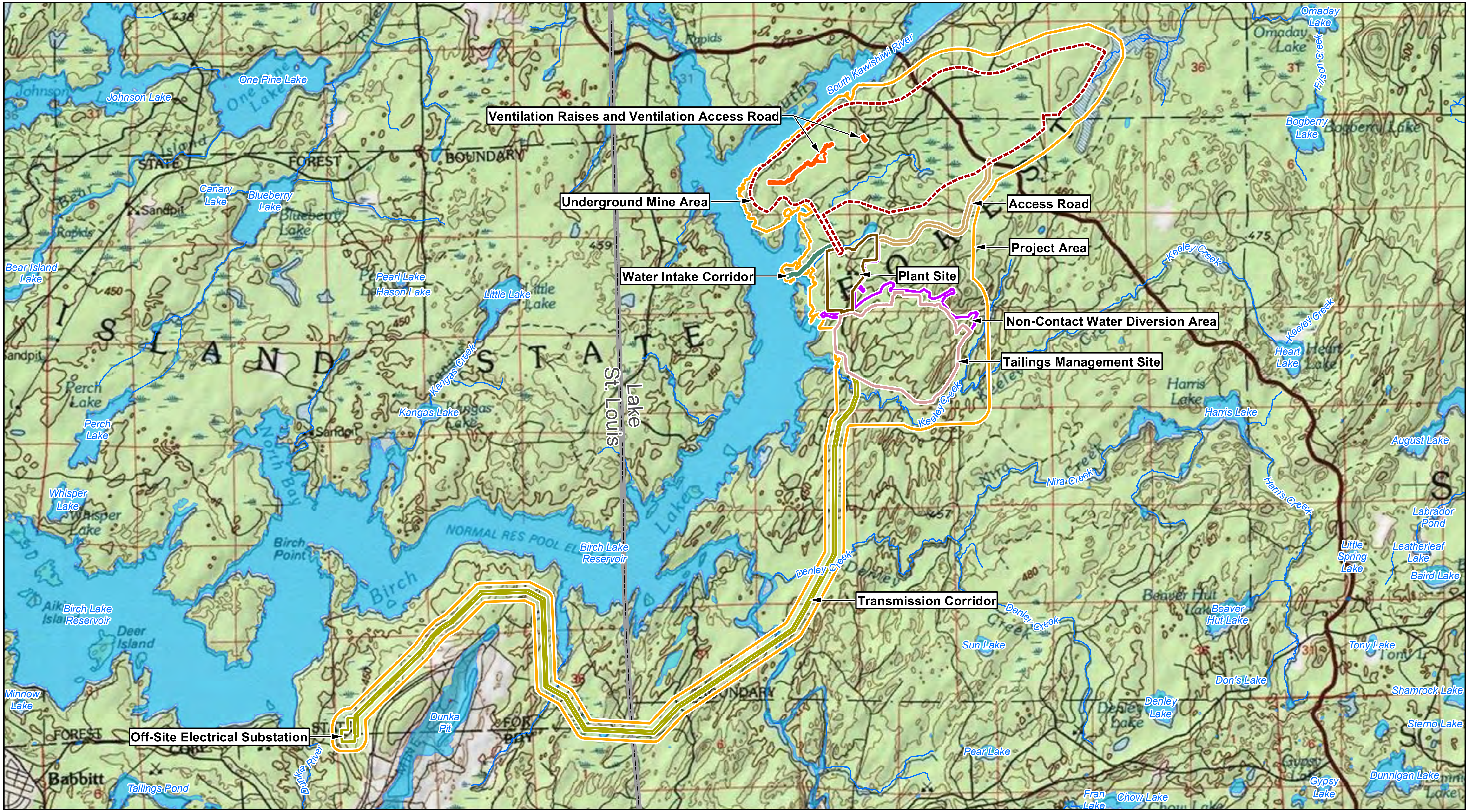
TWIN METALS MINNESOTA

**FIGURE 3-12**

BEDROCK CROSS SECTION D-D'
UNDERGROUND MINE

Horizontal & Vertical Scale: 0 750 1,500 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. USDA Topographic basemap supplied by esri.
2. Project related facilities and road data supplied by Twin Metals Minnesota
3. Hydrographic data from MDNR.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- 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

TWIN METALS MINNESOTA

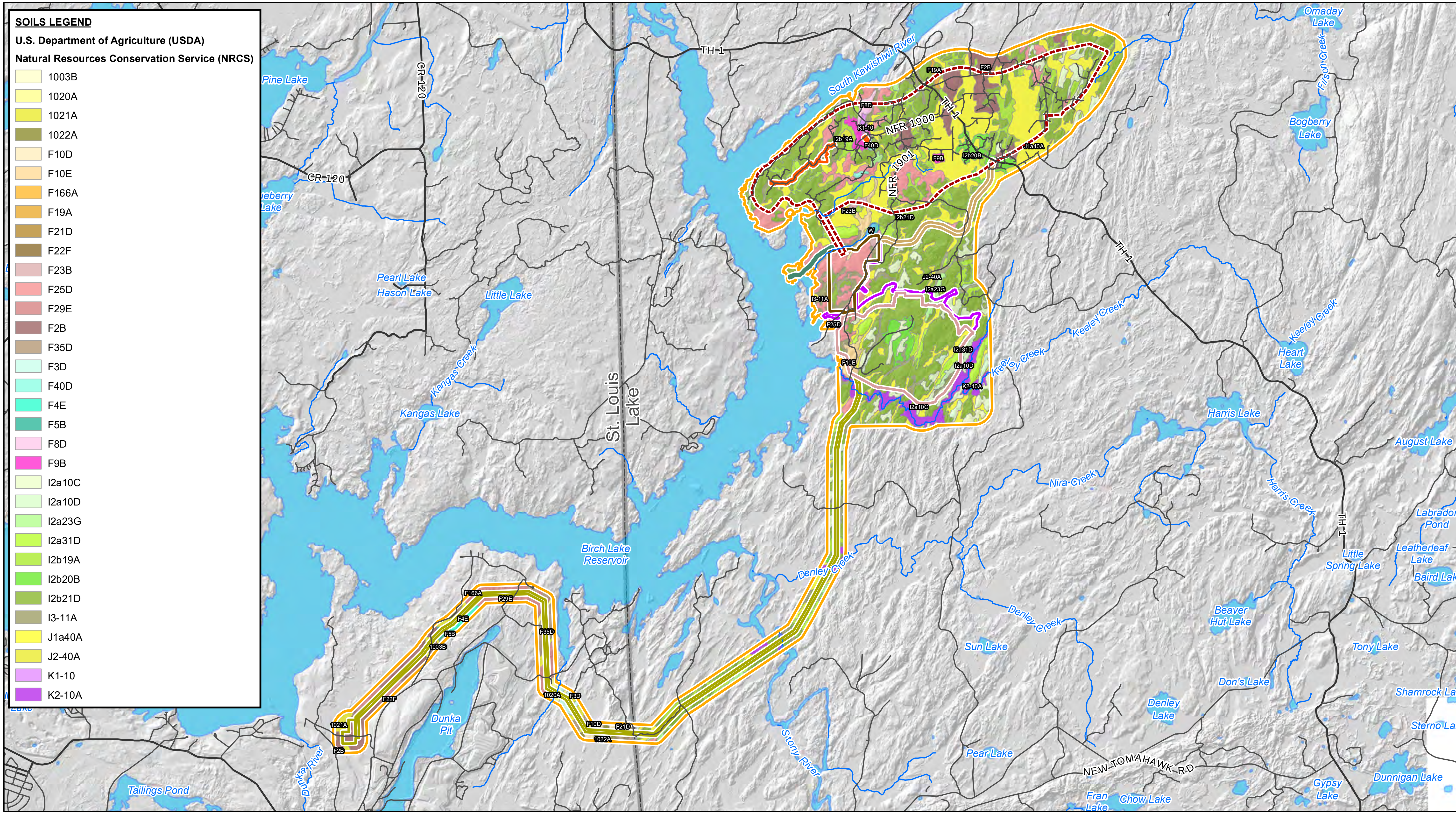
TWIN METALS MINNESOTA

**FIGURE 3-13**

PROJECT AREA TOPOGRAPHY

Scale: 0 2,500 5,000 Feet

Date: September 2019




**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. Soils data downloaded from the U.S. Department of Agriculture (https://websoilsurvey.sc.egov.usda.gov).
4. See Table 5-1 for soil descriptions.

**LEGEND**

- Primary Road
- Secondary Road
- River/Stream
- 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

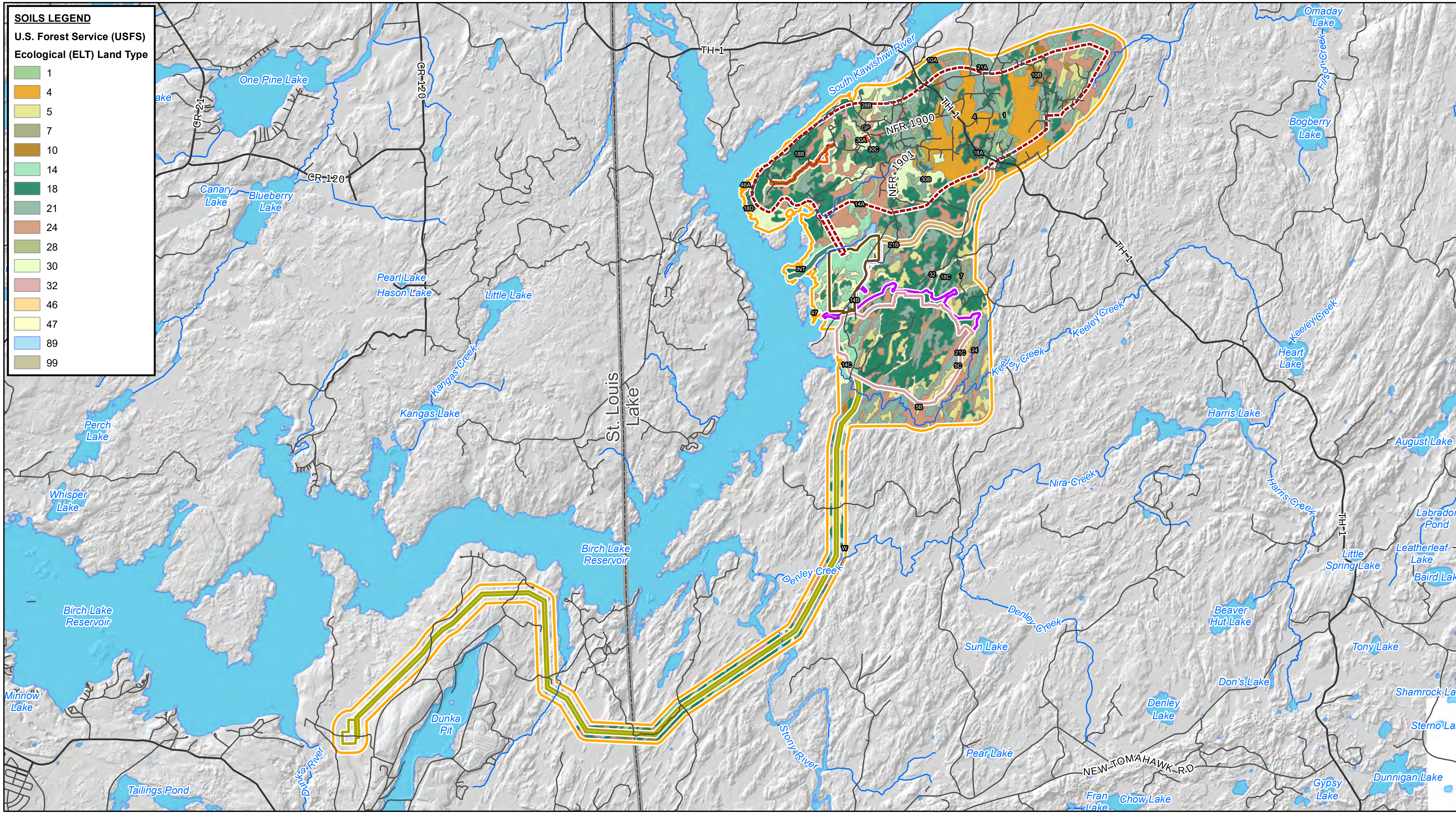
TWIN METALS MINNESOTA

**FIGURE 3-14**

U.S. DEPARTMENT OF AGRICULTURE NRCS SOILS DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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. Terrestrial Ecological Unit Inventory (soils) data from the United States Forest Service.
4. See Table 5-2 for soil descriptions.

**LEGEND**

- River/Stream
- Primary Road
- Secondary Road
- 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

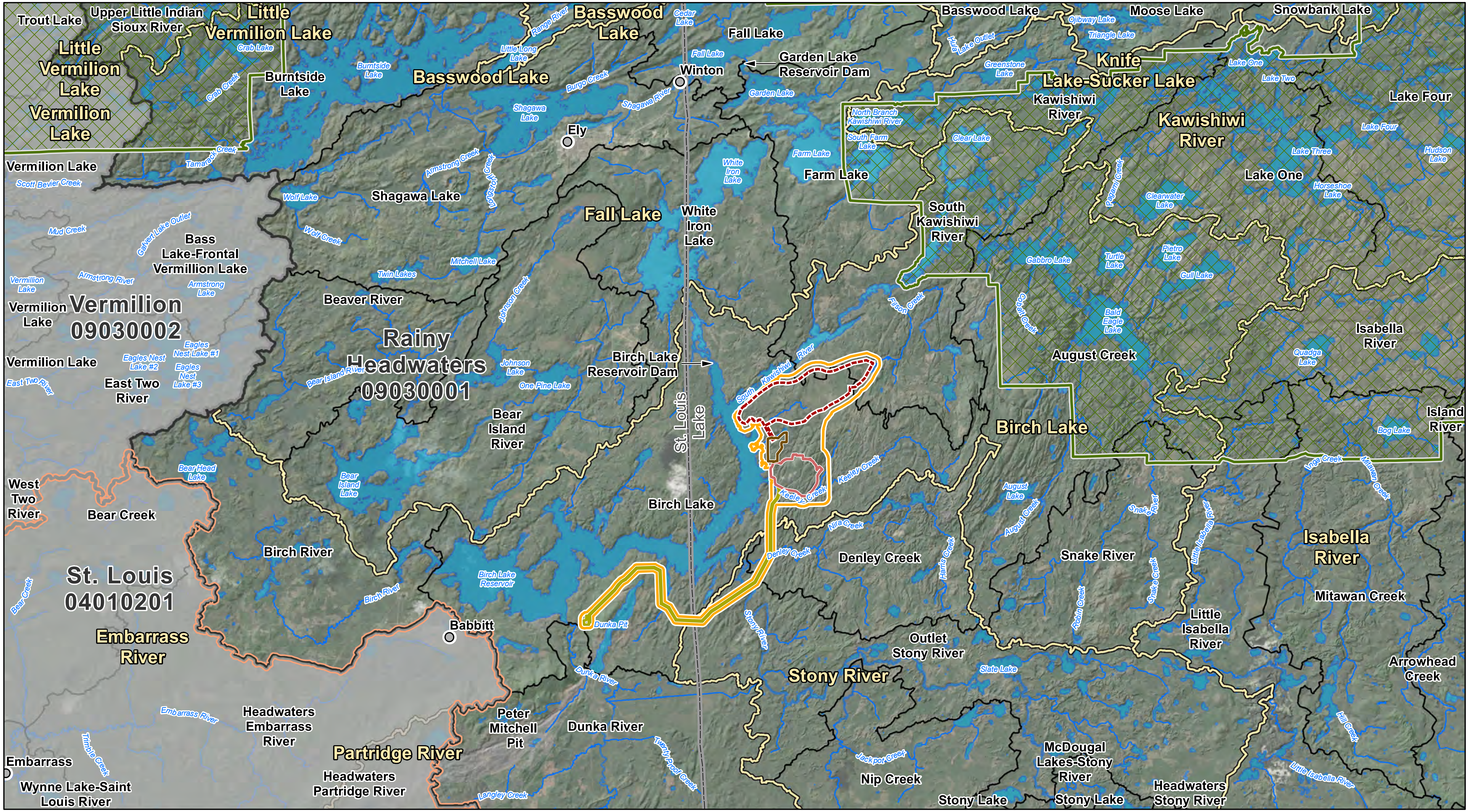
TWIN METALS MINNESOTA

**FIGURE 3-15**

U.S. FOREST SERVICE ELT SOILS DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. Base air photo from Esri World Imagery map service.
2. Watershed data from the U.S. Geological Survey Watershed Boundary Dataset (WBD).
3. Hydrographic data from Minnesota Department of Natural Resources.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- Place Name
- River/Stream
- Lake/Pond
- Watershed Boundary Hydrological Unit Code 8
- Watershed Boundary Hydrological Unit Code 10
- Watershed Boundary Hydrological Unit Code 12
- Laurentian Divide
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Transmission Corridor

TWIN METALS MINNESOTA

N

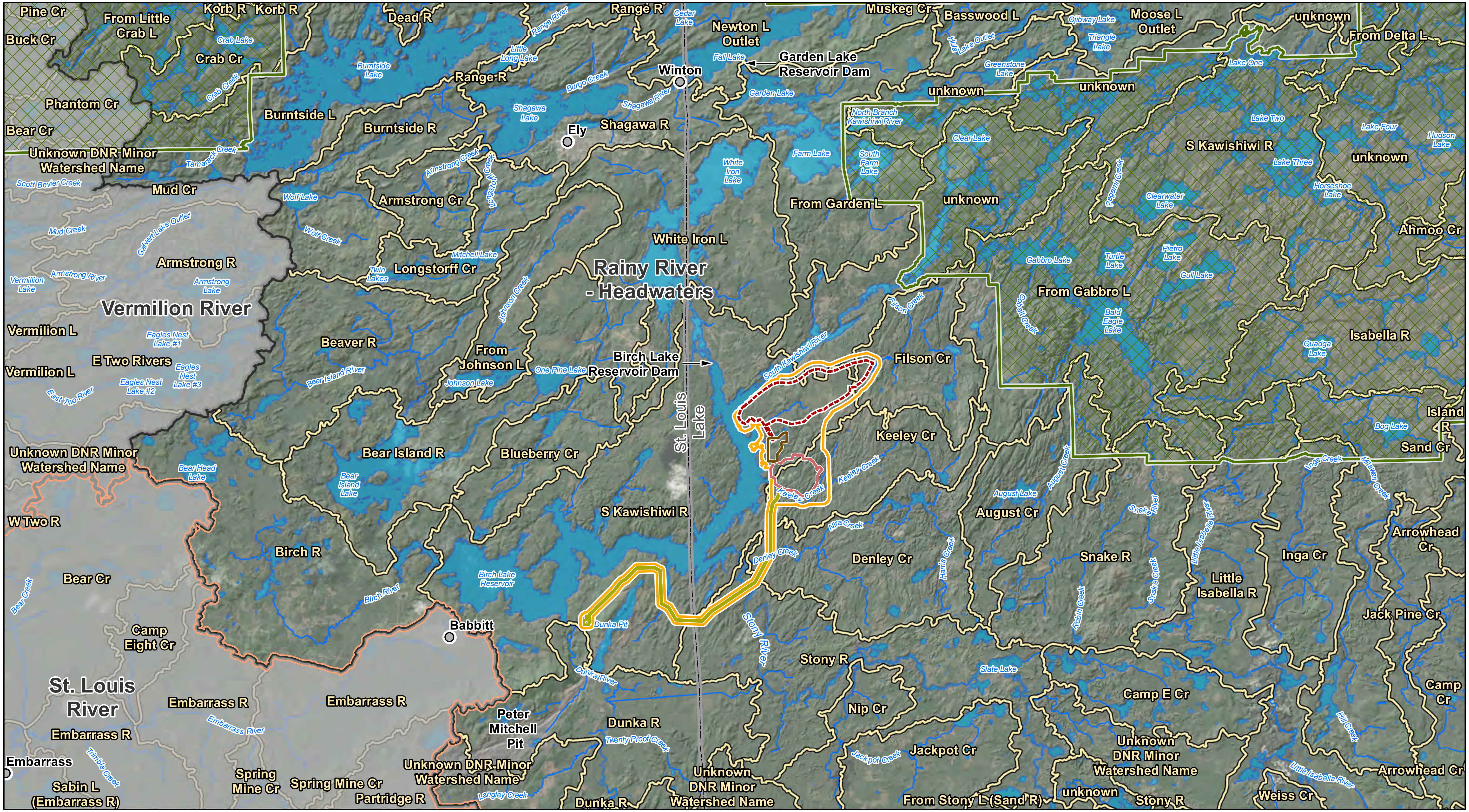
Scale: 0 1.25 2.5 Miles

TWIN METALS MINNESOTA

**FIGURE 3-16**

U.S. GEOLOGICAL SURVEY HYDROLOGICAL UNIT CODE WATERSHEDS

Date: SEPTEMBER 2019




**NOTES:**

1. Base air photo from Esri World Imagery map service.
2. Hydrographic and watershed data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- Place Name
- Major Watershed Boundary
- Minor Watershed Boundary
- River/Stream
- Lake/Pond
- Laurentian Divide
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Transmission Corridor

TWIN METALS MINNESOTA

N

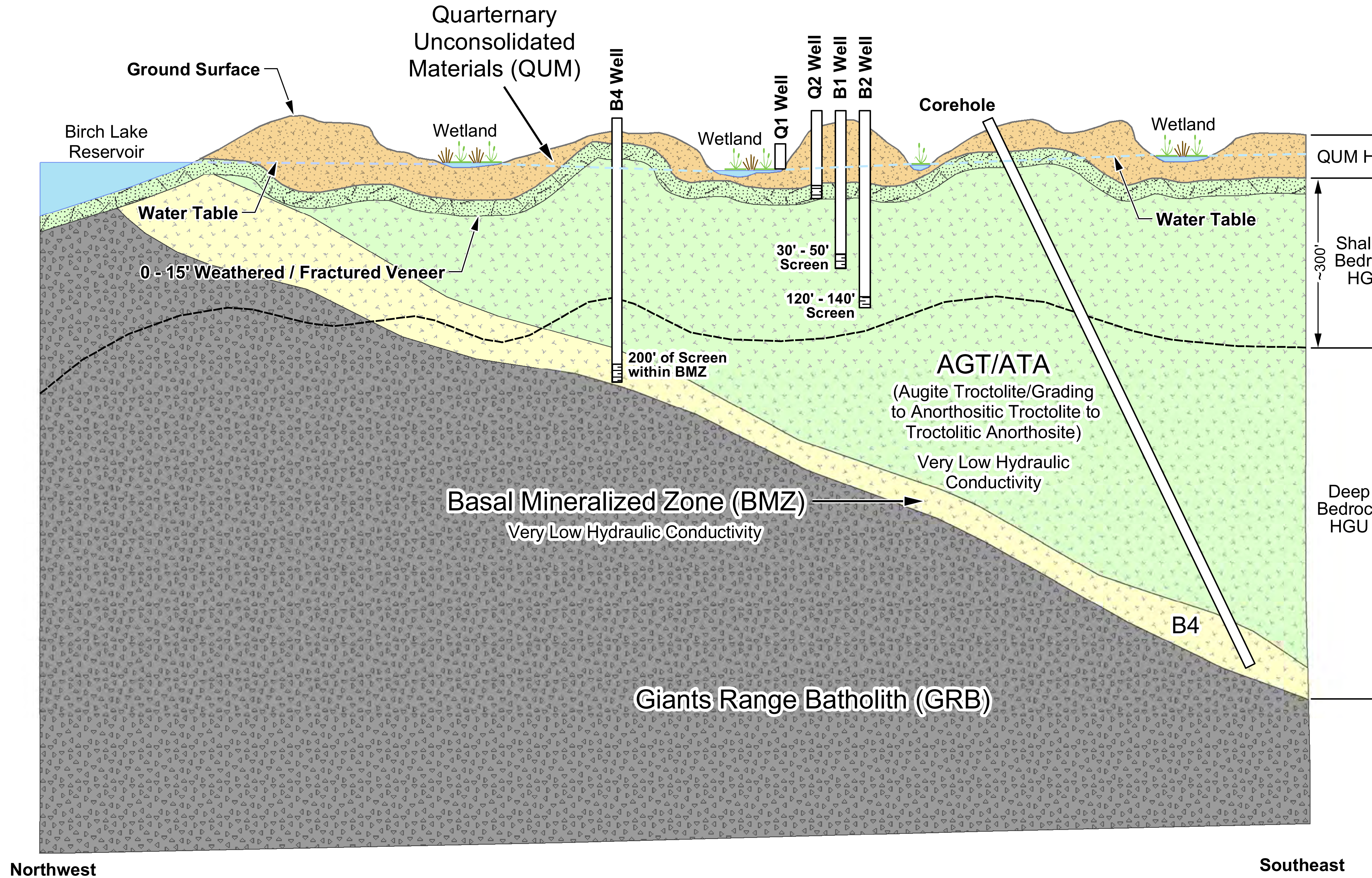
Scale: 0 1.25 2.5 Miles

TWIN METALS MINNESOTA

**FIGURE 3-17**

MINNESOTA DEPARTMENT OF NATURAL RESOURCES WATERSHEDS

Date: SEPTEMBER 2019



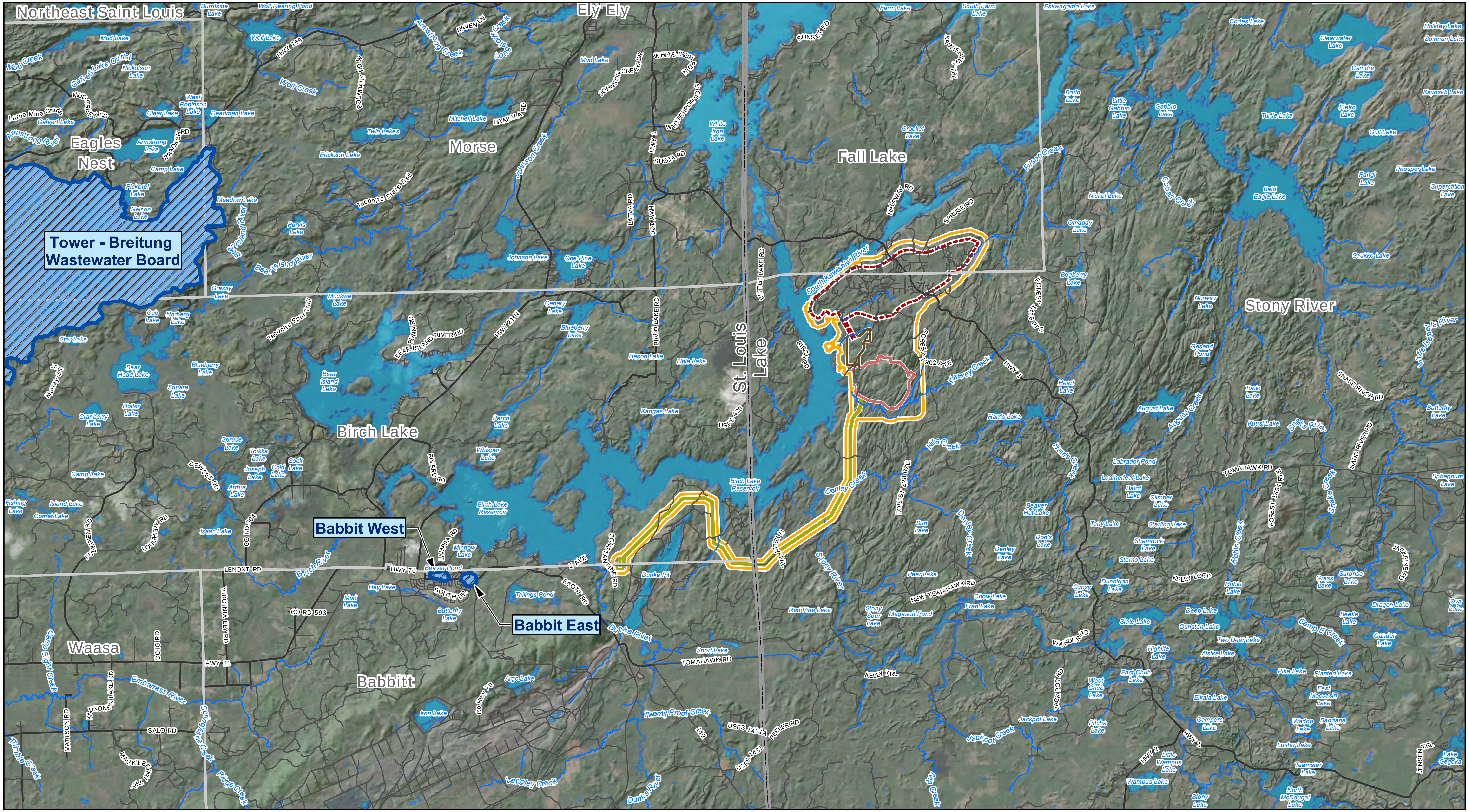

**NOTES:**
1. Figure is conceptual, not to scale and to be used for purposes of discussion.

TWIN METALS MINNESOTA

**FIGURE 3-18**

CONCEPTUAL HYDROLOGIC MODEL - HGUS

| Scale: NOT TO SCALE | Date: SEPTEMBER 2019 |
|---|---|




**NOTES:**
1. Base air photo from Esri World Imagery map service.
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. Wellhead protection areas from Minnesota Department of Health.

**LEGEND**
- Wellhead Protection Area
- River/Stream
- Primary Road
- Secondary Road
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Transmission Corridor

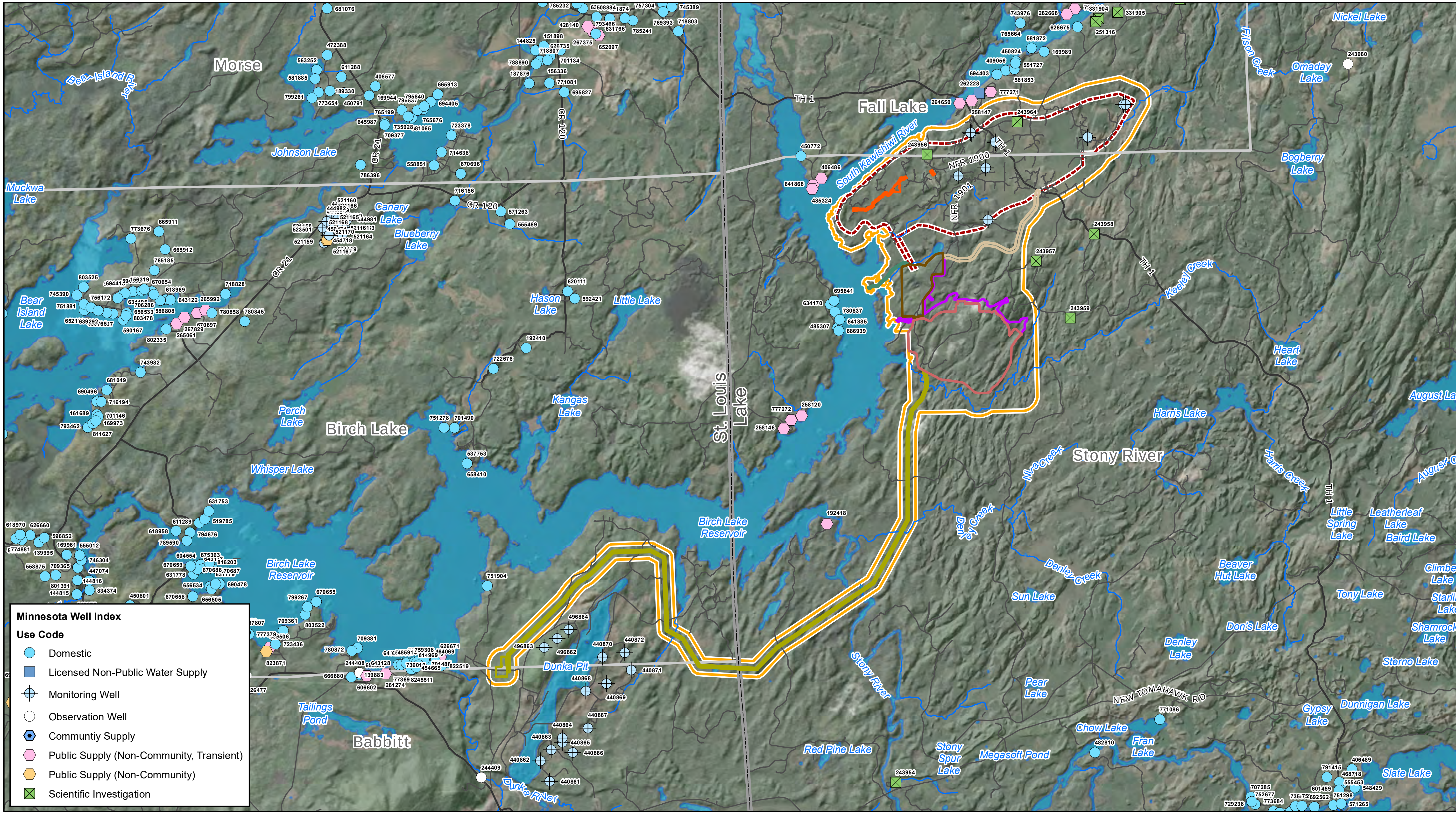
TWIN METALS MINNESOTA

**FIGURE 3-19**

WELLHEAD PROTECTION AREA

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019




**NOTES:**

1. Base air photo from Esri World Imagery map service.
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. Minnesota Well Index data from Minnesota Geological Survey (October 2018).

**LEGEND**

- River/Stream
- Primary Road
- Secondary Road
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raise and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

N

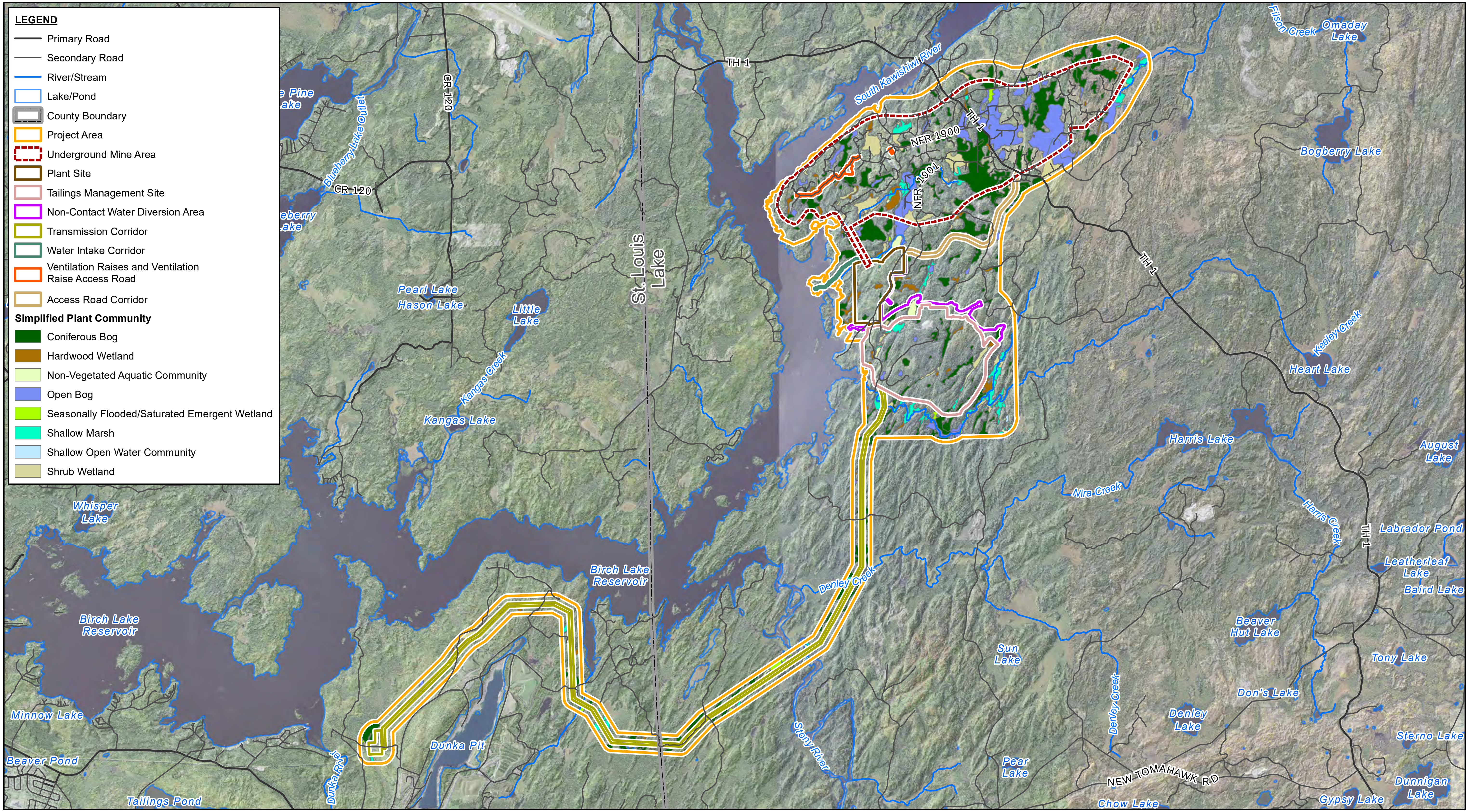
TWIN METALS MINNESOTA

**FIGURE 3-20**

MINNESOTA WELL INDEX MAP

Scale: 0 3,000 6,000 Feet

Date: SEPTEMBER 2019




**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

TWIN METALS MINNESOTA

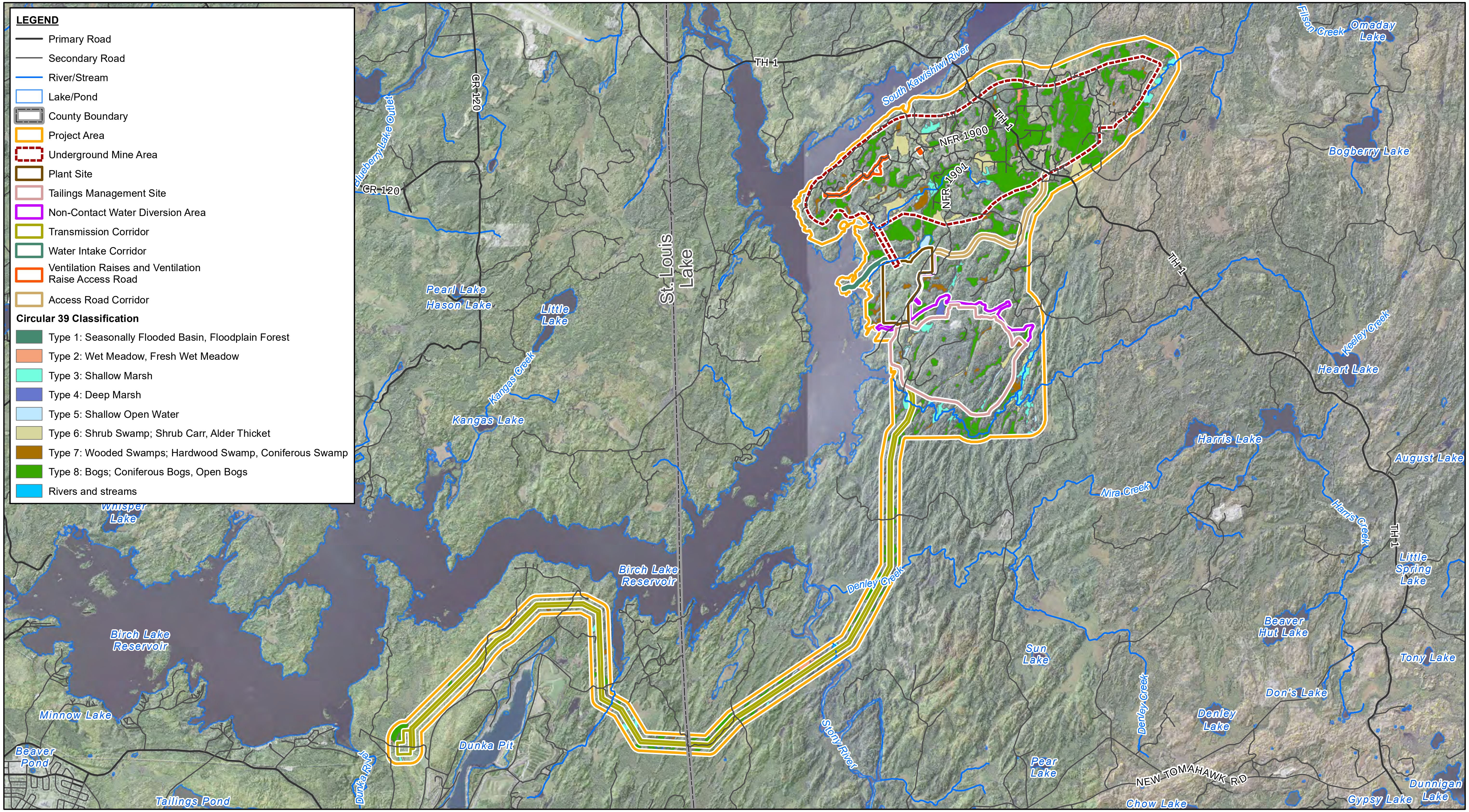
**FIGURE 3-21**

NATIONAL WETLANDS INVENTORY SIMPLIFIED PLANT COMMUNITY CLASSIFICATION

N

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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).

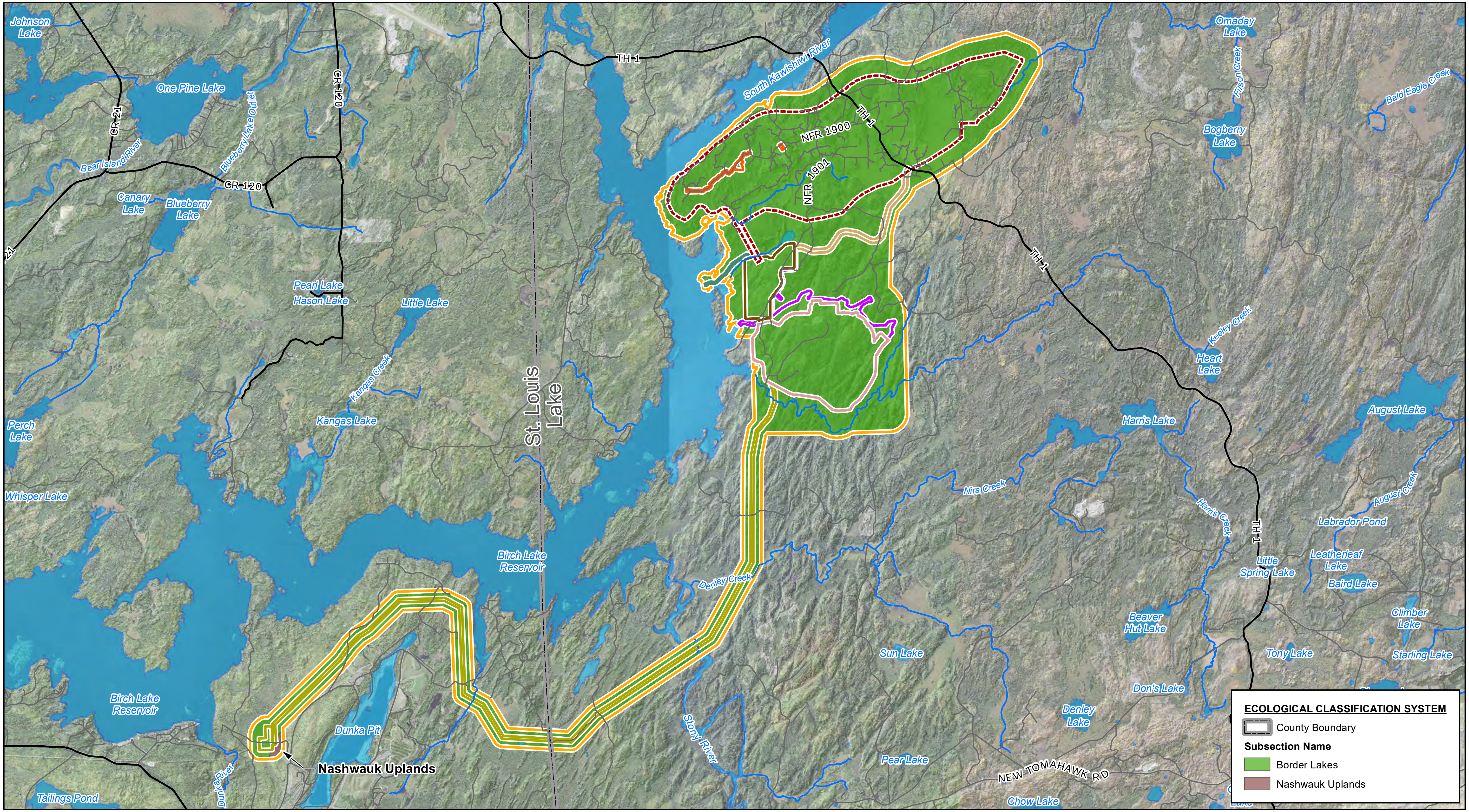
TWIN METALS MINNESOTA

**FIGURE 3-22**

NATIONAL WELTANDS INVENTORY
CIRCULAR 39 CLASSIFICATION

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and Ecological Classification System (ECS) data from Minnesota Department of Natural Resources.
3. 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

TWIN METALS MINNESOTA

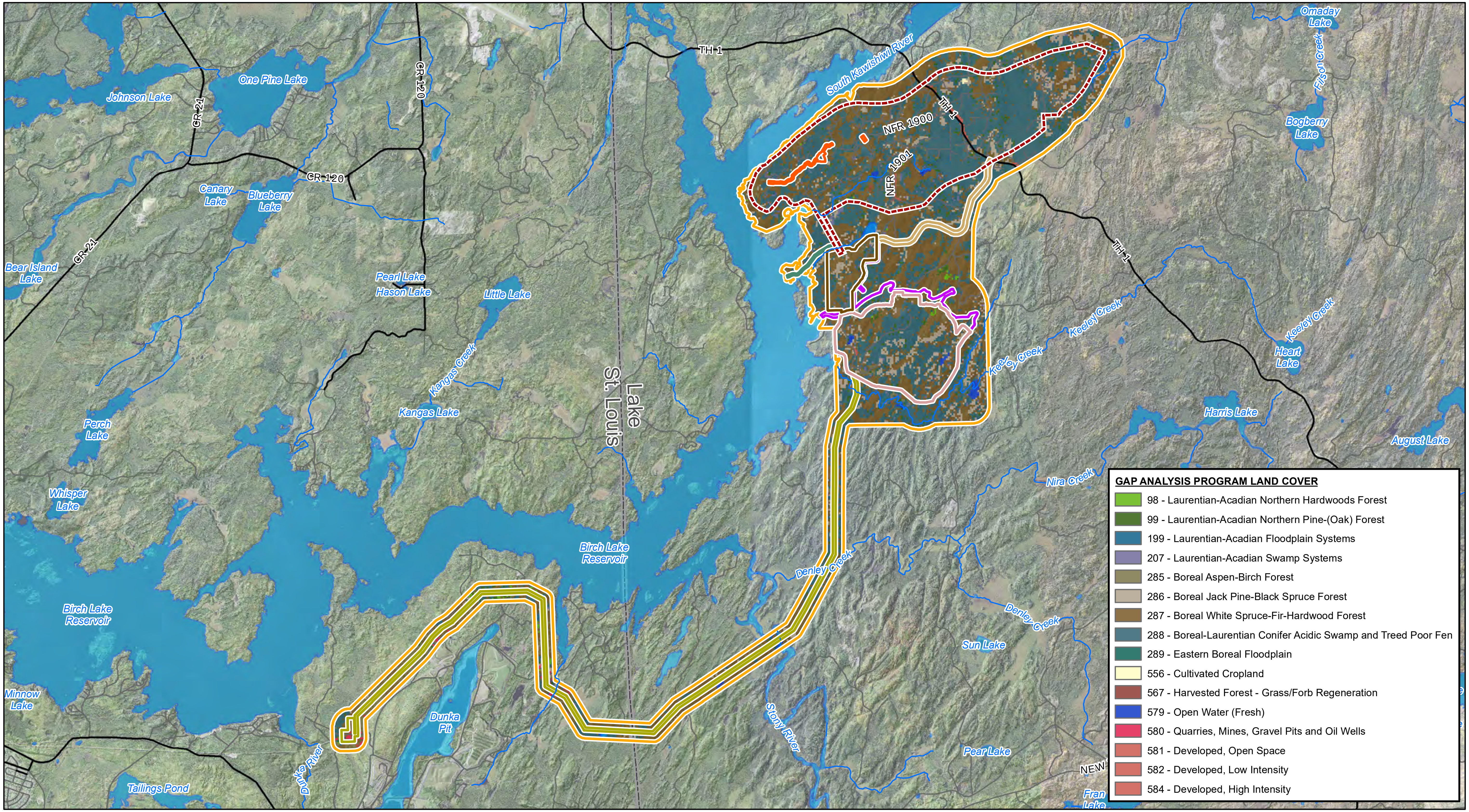
**FIGURE 3-23**

ECOLOGICAL CLASSIFICATION SYSTEM SUBSECTIONS

N

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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. GAP Land Cover data downloaded from the U.S. Geological Survey. https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/land-cover

**LEGEND**

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- County Boundary
- 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

N

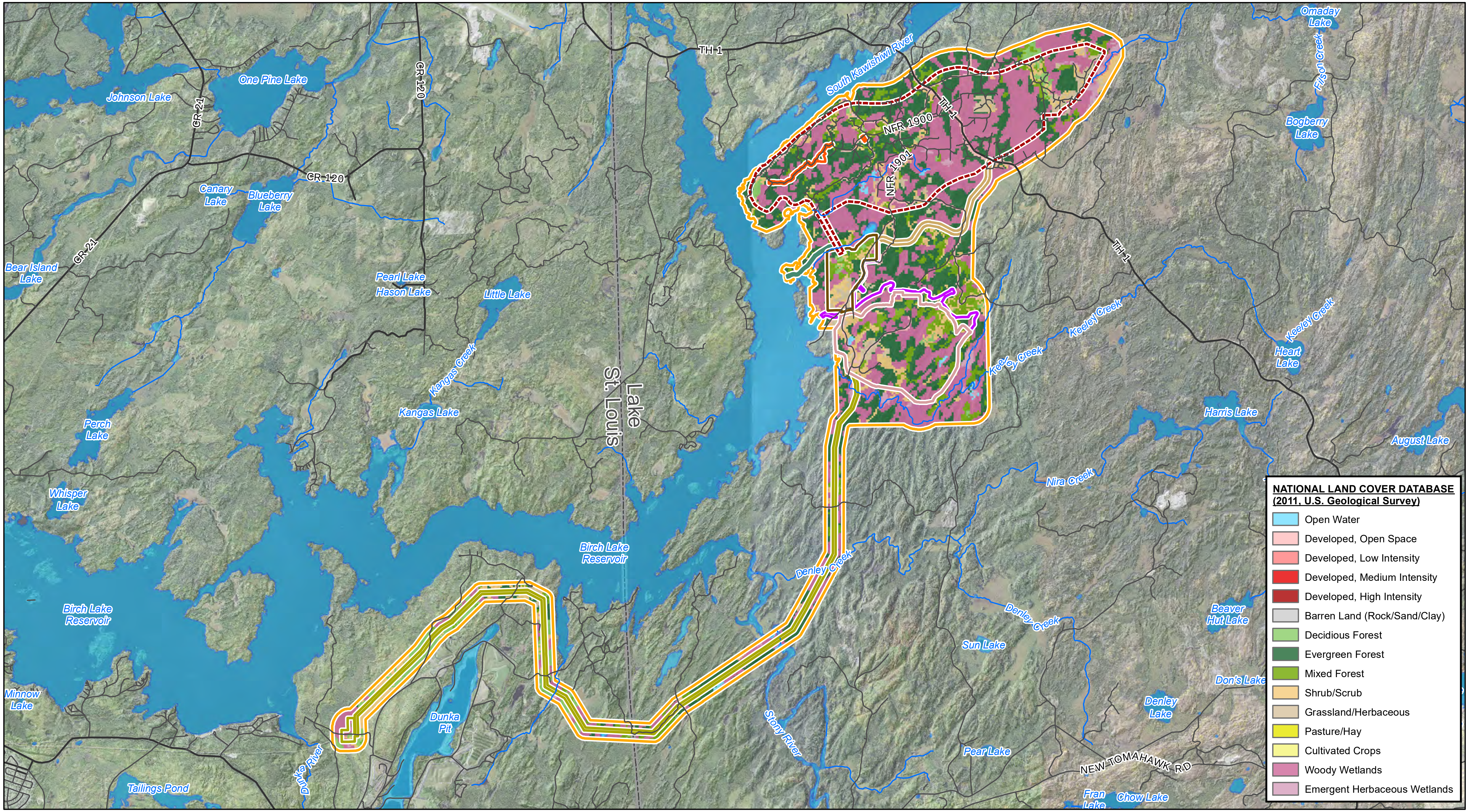
TWIN METALS MINNESOTA

**FIGURE 3-24**

U.S. GEOLOGICAL SURVEY NATIONAL GAP ANALYSIS PROGRAM PROJECT LAND COVER

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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. National Land Cover Database classification data downloaded from the U.S. Geological Survey. https://catalog.data.gov/dataset/usgs-national-land-cover-dataset-nlcd-downloadable-data-collection

**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

N

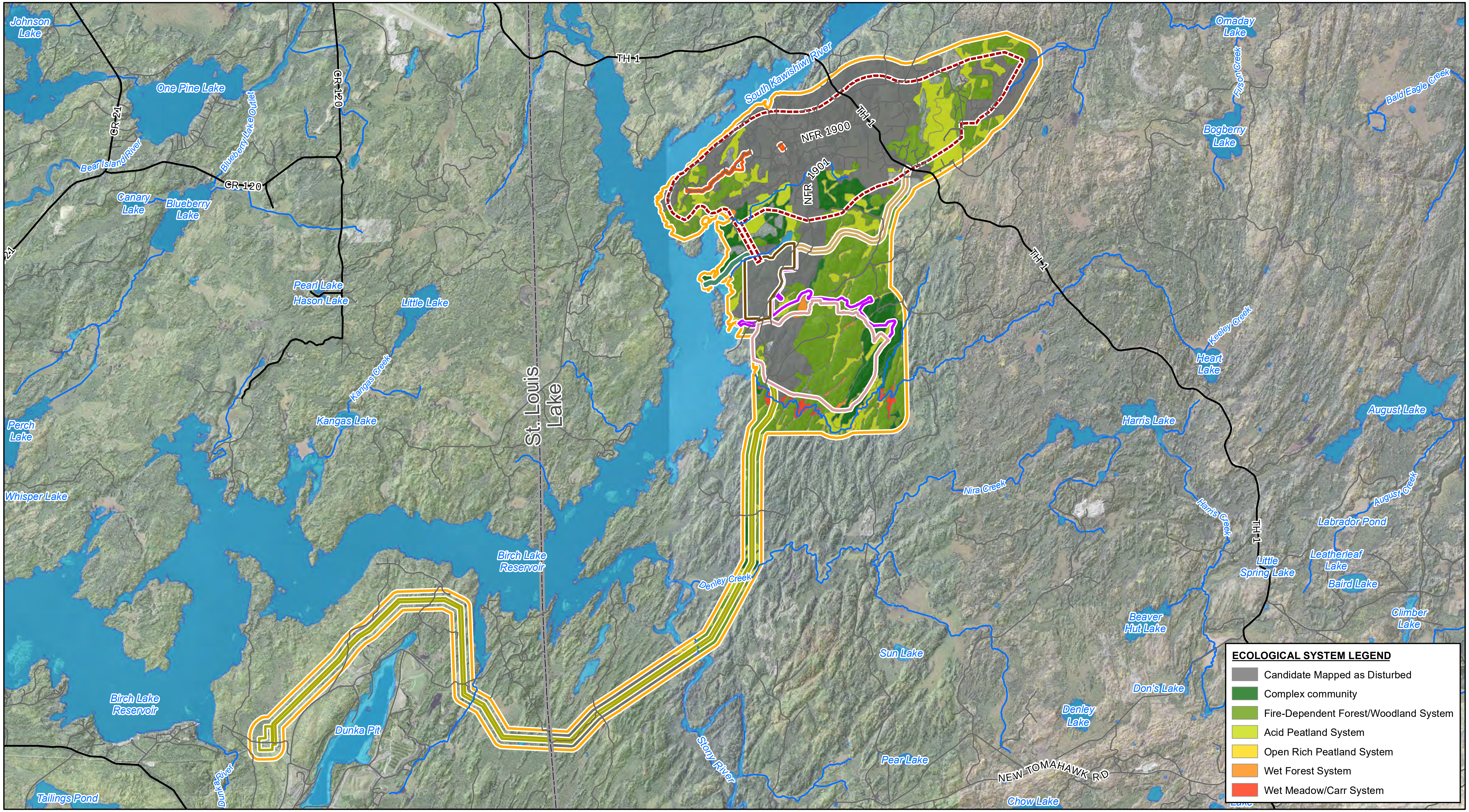
TWIN METALS MINNESOTA

**FIGURE 3-25**

U.S. GEOLOGICAL SURVEY NATIONAL LAND COVER DATABASE LAND COVER

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**NOTES:**

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and Minnesota Biological Survey (MBS) data from Minnesota Department of Natural Resources.
3. 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

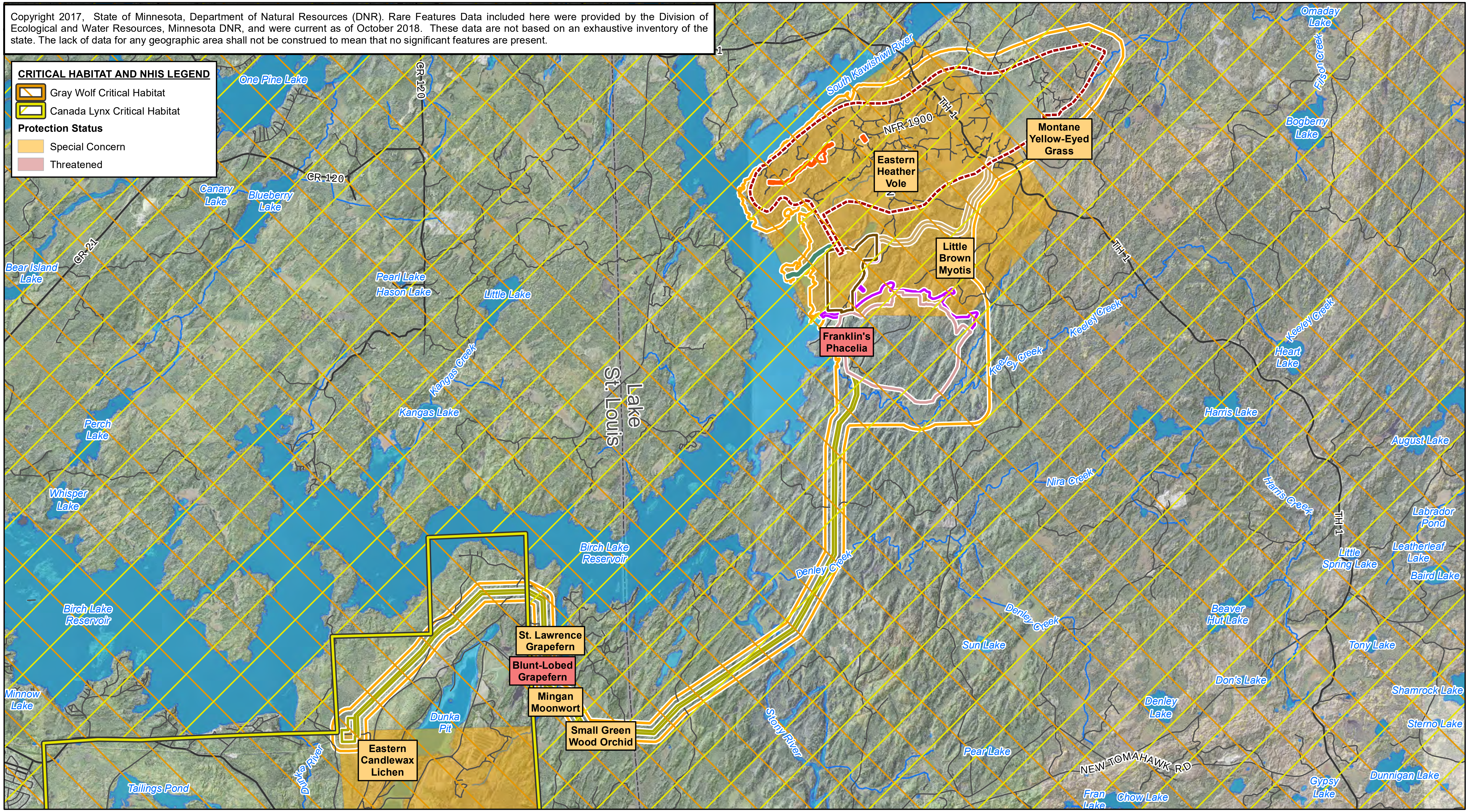
TWIN METALS MINNESOTA

**FIGURE 3-26**

MINNESOTA BIOLOGICAL SURVEY DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019




**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. Rare Features Data included here were provided by the Division of Ecological and Water Resources, Minnesota Department of Natural Resources. (See Copyright Statement above)
5. Critical Habitat Data downloaded from U.S. Fish and Wildlife Service.https://ecos.fws.gov/ecp/report/table/critical-habitat.html

**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

**FIGURE 3-27**

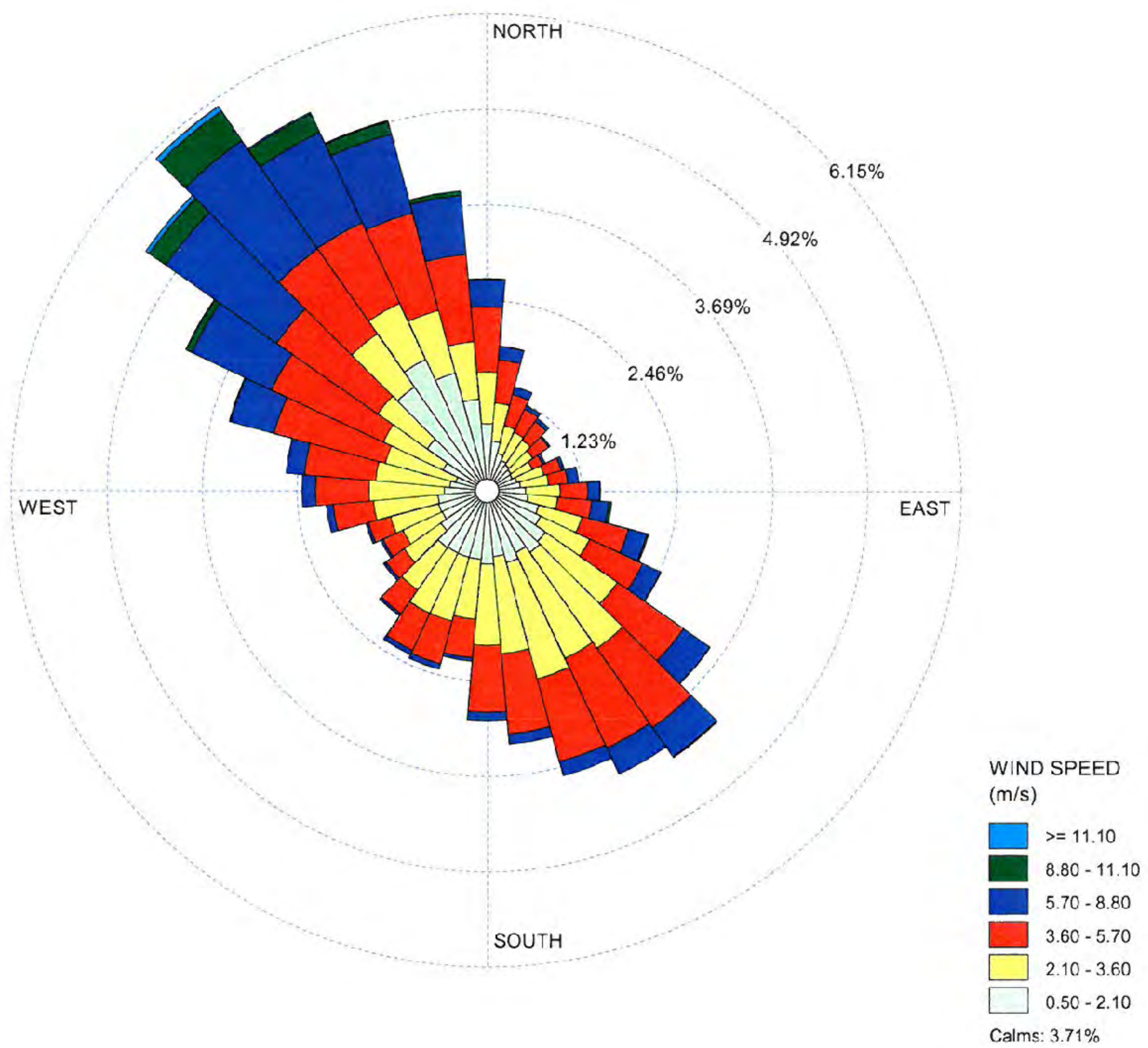
VEGETATIVE AND TERRESTRIAL WILDLIFE NHIS DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

WIND ROSE PLOT:
**Station #94931**

DISPLAY:
**Wind Speed**
**Direction (blowing from)**




| | | |
|---|---|---|
| COMMENTS:<br>Jan 1 to March 31, 2016 | DATA PERIOD:<br>**Start Date: 1/1/2012 - 00:00**<br>**End Date: 12/31/2016 - 23:59** | COMPANY NAME:<br>**Foth Infrastructure & Environment, LLC** |
| | CALM WINDS:<br>**3.71%** | TOTAL COUNT:<br>**43712 hrs.** |
| | AVG. WIND SPEED:<br>**3.37 m/s** | DATE:01/19/2018<br>**7/18/2019** |
| | | PROJECT NO.:<br>**16T777** |

WRPLOT View - Lakes Environmental Software

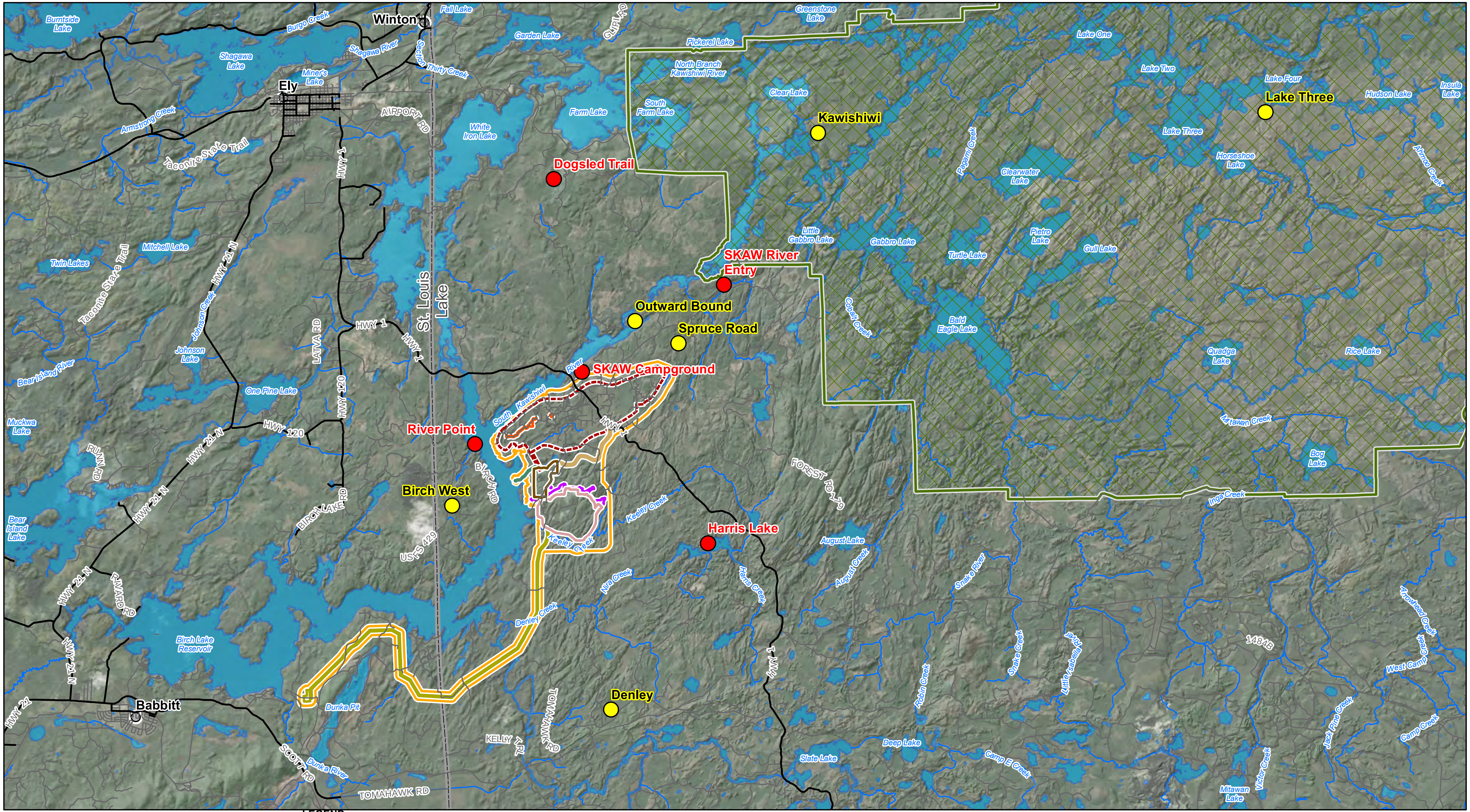
TWIN METALS MINNESOTA

TWIN METALS MINNESOTA

**FIGURE 3-28**

WIND ROSE

| | |
|---|---|
| Scale: Not to Scale | Date: 09/24/2019 |




**NOTES:**

1. Base air photo from Esri World Imagery map service.
2. Project related facilities supplied by Twin Metals Minnesota.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

**LEGEND**

- Ambient Noise Measurements taken Jan-Mar
- Ambient Noise Measurements taken April - Oct
- Primary Road
- Secondary Road
- Place Name
- 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
- Boundary Waters Canoe Area Wilderness
- Project Area
- Underground Mine Area

TWIN METALS MINNESOTA

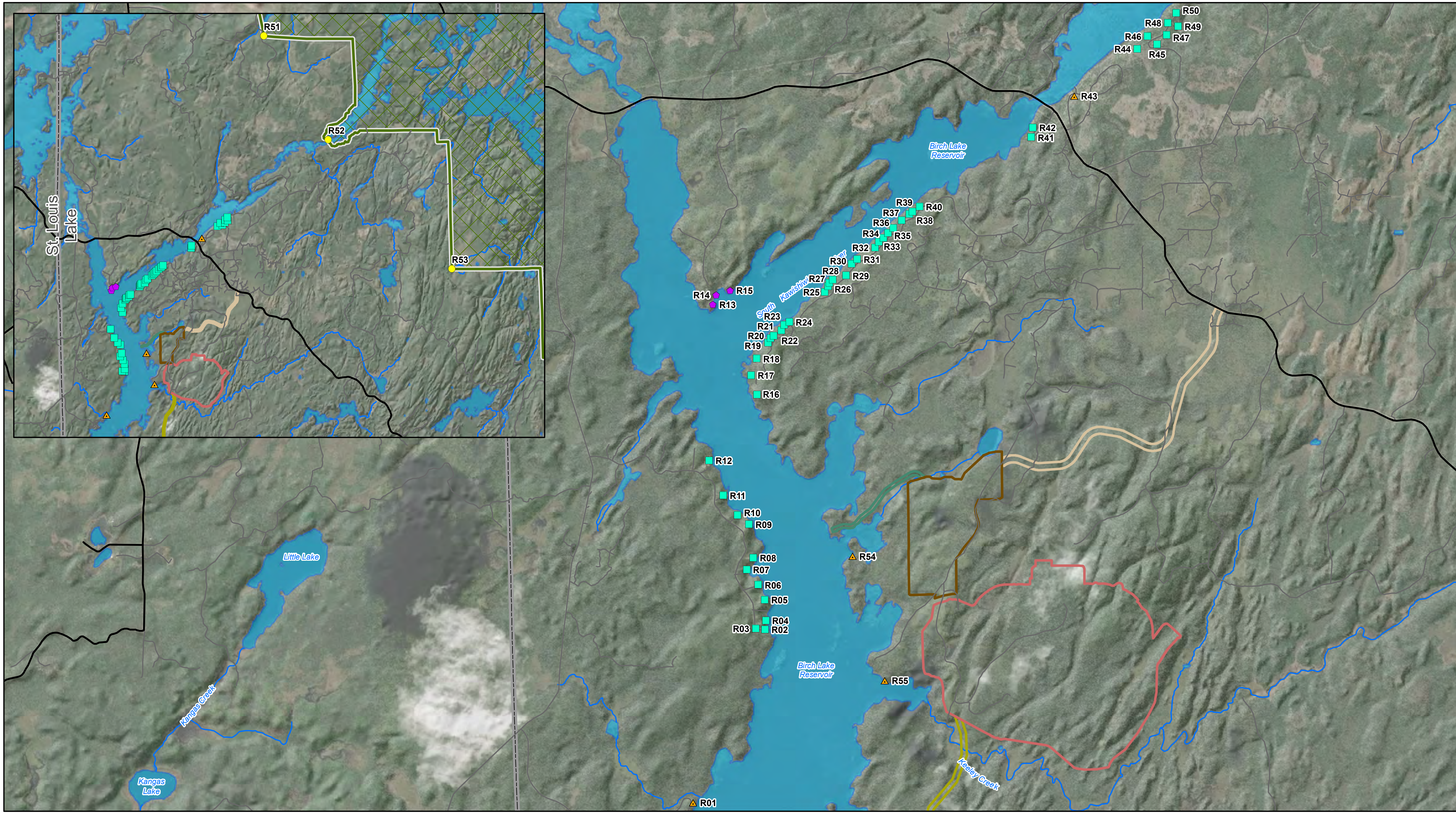
TWIN METALS MINNESOTA

**FIGURE 3-29**

U.S. FOREST SERVICE AMBIENT NOISE MEASUREMENT LOCATIONS

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019




**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**

- Boundary Waters
- Recreation
- Residence
- Resort
- Primary Road
- Secondary Road
- Place Name
- River/Stream
- Plant Site
- Tailings Management Site
- Transmission Corridor
- Water Intake Corridor
- Access Road Corridor
- Lake/Pond
- County Boundary
- Boundary Waters Canoe Area Wilderness

TWIN METALS MINNESOTA

N

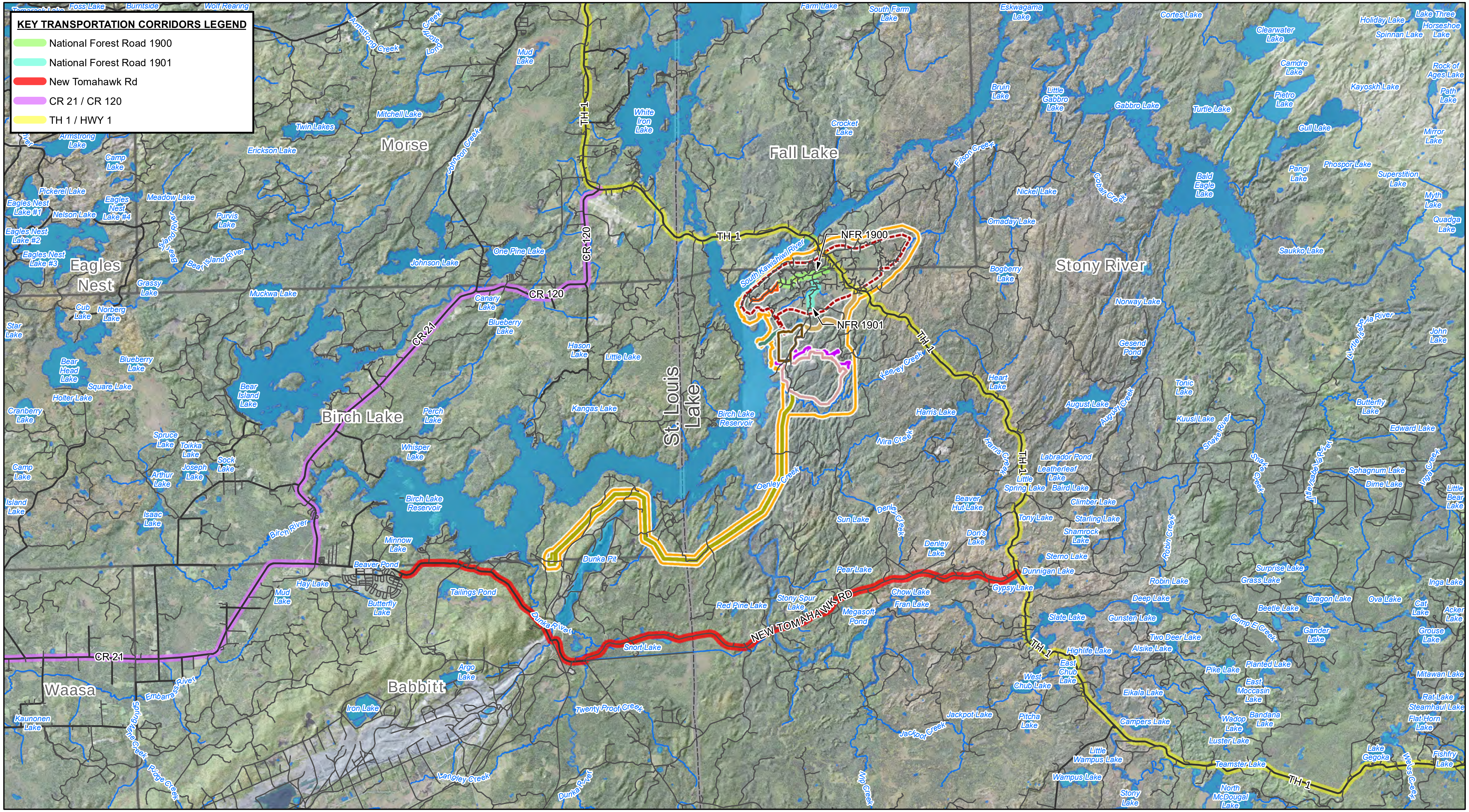
TWIN METALS MINNESOTA

**FIGURE 3-30**

SENSITIVE RECEPTORS - NOISE

Scale: 0 0.25 0.5 Miles

Date: SEPTEMBER 2019




**NOTES:**

1. Base air photo from the USDA Farm Service Agency, Aerial Photography Field Office.
2. Project related facilities and road data supplied by Twin Metals Minnesota
3. Hydrographic data from MDNR.
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
- 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
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area

TWIN METALS MINNESOTA

**FIGURE 3-31**

KEY TRANSPORTATION CORRIDORS

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019