Need for a Tamarack Region Sulfide Ore Study:

Environmental Baseline Data and Mining Effects

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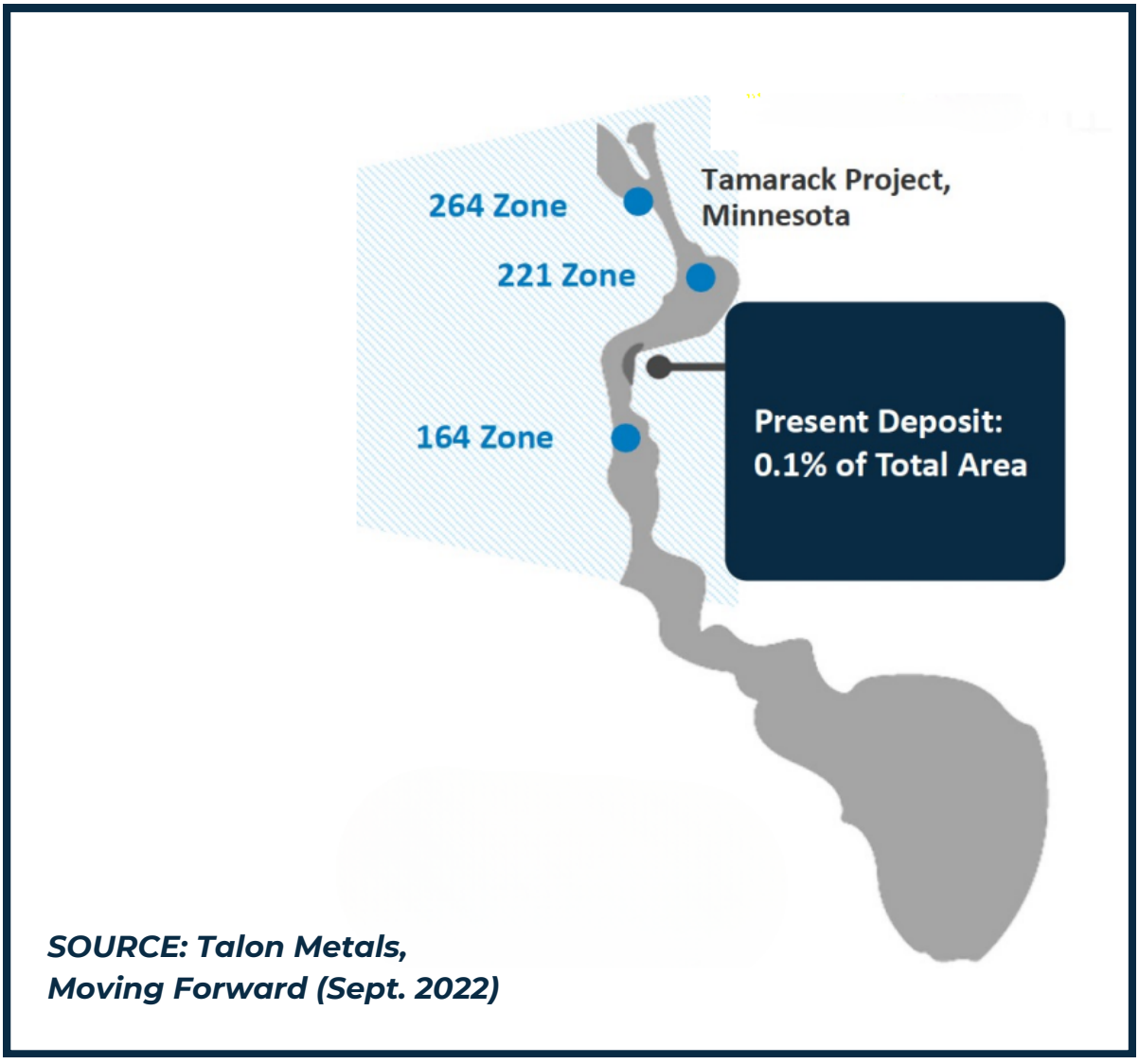
April 2024



SOURCE: Talon Metals, Moving Forward (Sept. 2022)

SUMMARY

Talon Metals and Rio Tinto Kennecott Exploration (Rio Tinto) are proposing to mine the Tamarack Intrusive Complex in the Mississippi River Basin. They control approximately 31,000 acres of mineral leases. Although the State of Minnesota studied the potential for a new mining district for sulfide ores in the Duluth Complex region more than 40 years ago, this 1979 Regional Copper-Nickel Study did not study the cumulative environmental, social, and economic impacts of mining for sulfide ore in the Tamarack region. Baseline data in the Tamarack region are not adequate to identify and avoid, minimize, and mitigate impacts through regulatory oversight. In addition, several environmental, social, and cultural issues that would be highly salient in this region under today's science and knowledge were not addressed at all in the 1979 Minnesota study of the Duluth Complex and are not available to evaluate sulfide ore mining of the Tamarack Intrusive Complex and the Tamarack region.

REGIONAL COPPER-NICKEL STUDY

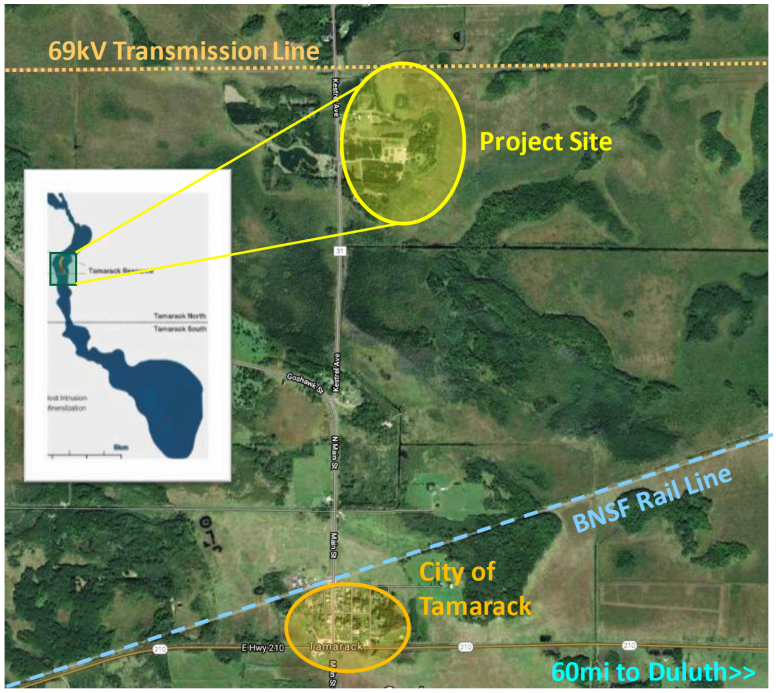
In 1974 the Minnesota Environmental Quality Board (MEQB) recognized that a new mining district for sulfide ores represented potential environmental impacts for a Minnesota geographical region that likely would extend far beyond the abilities of an Environmental Impact Statement (EIS) to assess. The MEQB adopted a resolution on October 8, 1974, requiring a "regional EIS be completed prior to the acceptance of any site specific EIS on any mining development proposal."[1] This resolution, amended on June 21, 1976, to require a "comprehensive regional study" rather than an EIS,[2] effectively placed a five-year moratorium on sulfide ore mining in the Duluth Complex region in order to complete a background study. The 1979 Regional Copper-Nickel Study[3] summarized:

> This study is being conducted for the Minnesota Legislature and state Executive Branch agencies, under the direction of the Minnesota Environmental Quality Board and with the funding, review, and concurrence of the Legislative Commission on Minnesota Resources. . .
>
> The Minnesota Environmental Quality Board is a state agency responsible for the implementation of the Minnesota Environmental Policy Act and promotes cooperation between state agencies on environmental matters. The Regional Copper-Nickel Study is an ad hoc effort of the MEQB and future regulatory and site specific environmental impact studies will most likely be the responsibility of the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency. . .
>
> The major objectives of the Regional Copper-Nickel Study are: 1) to characterize the region in its development state; 2) to identify and describe the

[1] MEQB, *Minnesota Copper-Nickel Regional Study* (1979) ("MEQB 1979"), Vol. 1 at 2.
[2] *Id*. (Emphasis in original).
[3] Thingvold, D. *et al.*, (Dec. 1979). *Water Quality Characterization of the Copper-Nickel Water Quality Research Area.* (Thingvold 1979).

probable technologies which may be used to exploit the mineral resource and to convert it into salable commodities; 3) to identify and assess the impacts of primary copper-nickel development and secondary regional growth; 4) to conceptualize alternative degrees of regional copper-nickel development; and 5) to assess the cumulative environmental, social, impacts of such hypothetical developments. The Regional Study is a scientific information gathering and analysis effort and will not present subjective social judgements on whether, where, when, or how copper-nickel development should or should not proceed. In addition, the Study will not make or propose state policy pertaining to development.[4]

The final 1979 Regional Copper-Nickel Study Report explained: "A 'regional study' was commissioned because it was believed that conventional site-specific environmental impact statements (EISs) and the corresponding regulatory process were inadequate to deal with the broader issues involving this unexploited resource."[5]



Talon Project Site Designated for Environmental Review Compared to Tamarack Intrusive Complex. Talon Metals, Moving Forward at 13 (Jan. 2023).

Today Minnesota similarly faces the potential impacts of a new proposed mining district in Aitkin County and Carlton County and the Sandy River (Mississippi River) and Kettle River (St. Croix River) watersheds. This mining district would affect air and water quality, tribal lands and waters, exercise of treaty-reserved rights, protected natural and cultural resources, and downstream residents of Minnesota's largest population center. We believe a Tamarack Region Sulfide Ore Study is required to set environmental baselines and to assess potential impacts of sulfide ore mining for the local and downstream regions, including environmental, public health, cultural, social, and economic factors. This paper summarizes pertinent background and outlines the need for baseline and cumulative data and effective regulatory oversight before considering mining in the Tamarack Intrusive Complex region.

[4] Thingvold 1979 at pdf 3.
[5] MEQB 1979, Vol. 1 at i.

DISCUSSION

Geology and Duluth Complex Regional Study

Approximately 1.1 billion years ago, convection currents in the earth's mantle created a rising plume of molten material that caused a rift in the earth's crust, near the center of the North American continent. This rift, termed the "Midcontinent Rift," extends west from Michigan to Minnesota, and as far south as Kansas. The Midcontinent Rift enabled the emplacement of a series of magmatic intrusions, including the Duluth Complex, into pre-existing rocks, including granites, sandstones, and iron formations. The Midcontinent Rift also resulted in a related period of significant volcanic activity, forming a thick sequence of lava flows along and adjacent to the rift. The magmatic intrusions created a number of metal sulfide and oxide deposits in parts of Northeast and North Central Minnesota. The sulfide deposits were first identified near Ely, Minnesota, in 1948. Iron-titanium oxide deposits were also considered to be potentially of economic value at about that same time (Miller *et al*., 2002).

As early as 1967, several mining companies' exploration activities identified and defined Duluth Complex metal sulfide deposits and concluded that copper and nickel could potentially be economically recovered (Miller, 2002). In 1974 the State of Minnesota recognized that the Duluth Complex had an increasing potential of becoming a new sulfide mining district. The State also understood, among other concerns, that there was a void of data as to the wastes that could be produced by mining, and that regional environmental baselines would be required. The potential impacts from the development of any future sulfide mines would be nearly impossible to assess without these data. These data gaps would not allow regulatory protection of the regional environment if a new sulfide mining district were developed. This data gap resulted in a moratorium on sulfide mining in the region until a regional study could fill the gaps. This study remains relevant today. The resultant study provided significantly more data on the Duluth Complex Mining District's existing water, land, and air, including data regarding numerous identified chemicals of potential concern and toxicity from sulfide mining wastes from the Midcontinent Rift. Although scientific knowledge as to toxicity and interaction of chemicals has advanced in the past 44 years, the Copper-Nickel Study of the Duluth Complex Region provides a baseline that is still used today.

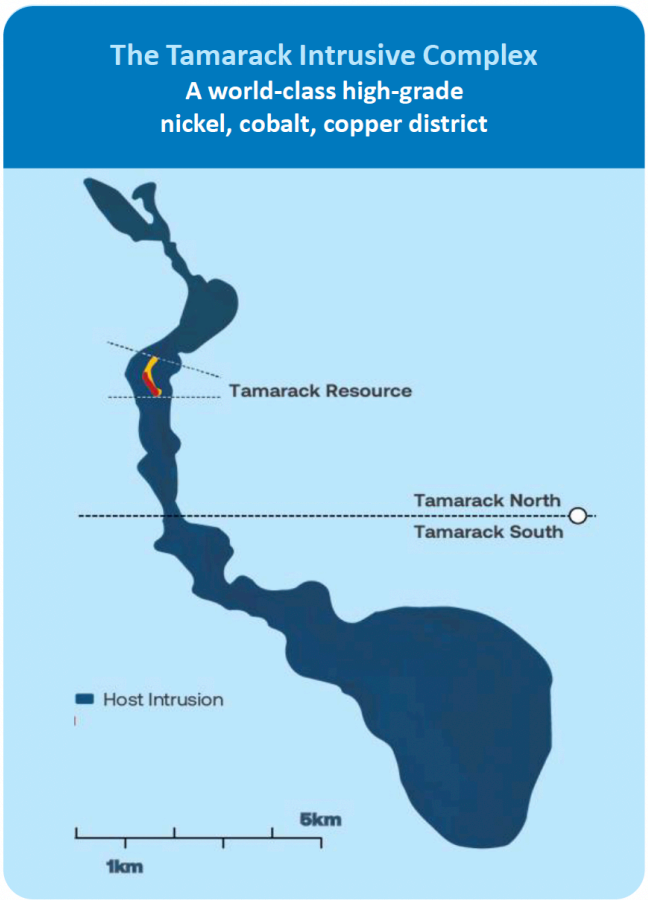
The area covered in the previous Regional Copper-Nickel Study was limited to the Duluth Complex district in northeastern Minnesota within the Superior National Forest and adjacent to the Boundary Waters Canoe Area. (MEQB, 1979). This Study did not include other potential sulfide deposit areas that have been identified since 1979 and, specifically, did not include the Tamarack Intrusive Complex or the Tamarack region.[6]

Tamarack Intrusive Complex Potential Mining District

Another sulfide ore mineral deposit also related to the Midcontinent Rift was identified in Aitkin County and Carlton County, Minnesota, after the 1979 Regional Copper-Nickel Study was completed; that deposit is associated with the Tamarack Intrusive Complex. (Jirsa *et al.,* 2006).

[6] *See* MEQB 1979, Vol. 1 at 12-13.

The Tamarack Intrusive Complex is not as large as the Duluth Complex. However, it encompasses an area of over 30,000 acres that is currently covered by mining leases in Aitkin and Carlton Counties. (Baldwin, 2023). Other regional mineralization, including the Cuyuna Range, has been identified. As with the Duluth Complex mining district, mining the Tamarack Intrusive Complex region will have cumulative environmental, social, and economic impacts. Similarly, the conventional site-specific environmental impact statement (EIS) and the corresponding regulatory process are inadequate to deal with the broader issues involving an unexploited resource of this size.



Talon Metals identified "Tamarack Resource" Compared with Tamarack Intrusive Complex "world-class high-grade nickel, cobalt, copper district. Talon Metals, Moving Forward at 5 (Sept. 2022).

A mining district is typically not limited to a single mine but grows with incremental expansions of additional mining areas as potential economic deposits are located and publicly disclosed. Minnesota's iron and Duluth Complex mining development provide an example. EIS procedures historically used by Minnesota responsible governmental units, which address a single proposed mine as identified by a project proponent, are wholly inadequate to deal with the type of incremental mining expansion that results in long term major and cumulative environmental impacts.

Today's scientific knowledge of the Minnesota Midcontinent Rift mineralogy is considerably more robust than it was in 1979. Ecological science, understanding of climate change and resilience, and various aspects of environmental and public health have also developed in the past four and a half decades. Mining and pollution control techniques have also changed in the past 44 years. Some issues of great salience today were not analyzed in the 1979 Copper-Nickel Regional Study of the Duluth Complex. For example, none of the 31 chapters of the 1979 Study analyze impacts on tribal lands, waters, or airsheds or the exercise of treaty-reserved rights. Science related to sulfate, wild rice, release of nutrients and mercury from sediments, mercury methylation, and the effects of various parameters on aquatic life and human health has become far more robust since the 1979 Duluth Complex Regional Study.

Tamarack Intrusive Complex Regional Study Requirements

Significant background data and analytic work specifically related to the potential Tamarack Intrusive Complex regional mining district is necessary to identify and avoid, minimize, and mitigate cumulative impacts through enforceable regulatory oversight. State agencies should develop all data requirements, quality control and quality assurance plans, and analyses in mutual collaboration with federal and tribal regulatory agencies. The following list of data requirements is preliminary and not all-inclusive. Collaborative agencies working with an independent scientific panel should complete the rough outline provided below.

Historical Information

All historical information pertaining to regional and local geology, hydrology, water and air quality, ecological systems, health, and cultural features must be compiled and organized into this study. It should include publications and unpublished research by federal agencies, state agencies, tribes, NGOs, cultural historians, and academic and scientific researchers (*e.g*. Great Lakes Indian Fish and Wildlife Commission, Minnesota Geological Survey (MGS)). These sources must be evaluated to help identify data gaps, that is, areas where information needs more clarifications, and to establish an initial known database.

Sampling Plans and Quality Assurance/Quality Control (QA/QC)

All data collected must include sampling plans, how samples were acquired and any anomalies in the field procedures. QA/QC must include, but not be limited to, holding times, sample temperature constraints, masked field duplicates, documented laboratory methods used, and QA/QC for each sample analyzed. This QA/QC information is critical to ensure that later use of the data can be documented and that the methods used and results reported are appropriate for the future evaluation. All these data must be included in the reports' appendices, such that peer review of the results, the data acquisition procedures, and laboratory QA/QC can be verified (Francoeur ND., Defense 2019, USEPA 2002).

Geology

Current and historic data collected by exploration companies, including Talon, Kennecott, and others; data collected by the MGS, Minnesota Department of Natural Resources (DNR), and other public agencies; and data collected by private researchers, including drill cores, must be made available and analyzed to fully characterize the geology of the potential mining district. Geophysical and geochemical data, in addition to geologic maps, cross-sections, and other types of data, must be made available to the state and potentially interested parties. These data must include all available maps showing accurate locations for all drill holes and soil sampling sites. Soil and bedrock geochemical data must be compiled and any gaps identified. At a minimum, all of these types of data are essential to characterizing and understanding the geology and geochemistry of the potential mining district and its potential impacts on human health and the environment.

Hydrology
All available current and historic groundwater data must be compiled including data that may be available in exploration companies' files, published DNR, MGS, or independent reports, in published maps, or unpublished documents, such as dissertations or theses. At a minimum, these data must include: 1) maps showing locations for observation, monitoring, and private wells; 2) available water quality data; 3) sampling dates and locations (e.g., depth); 4) depth to groundwater; 5) groundwater flow directions and vertical gradients.

A rigorous and regional investigation of hydrology and hydrogeology must be completed using piezometers and pump testing to evaluate: 1) groundwater flow; 2) connections between aquifers; and 3) connections between groundwater, wetlands, and surface waters. Monitoring, as well as historical data throughout the entire region, must assess surface flow conditions, develop stream rating curves, and analyze how they would be affected by drought, flooding, and extreme weather conditions. Baseline flows and classification of stream orders should be made throughout the Tamarack Intrusive Complex region.

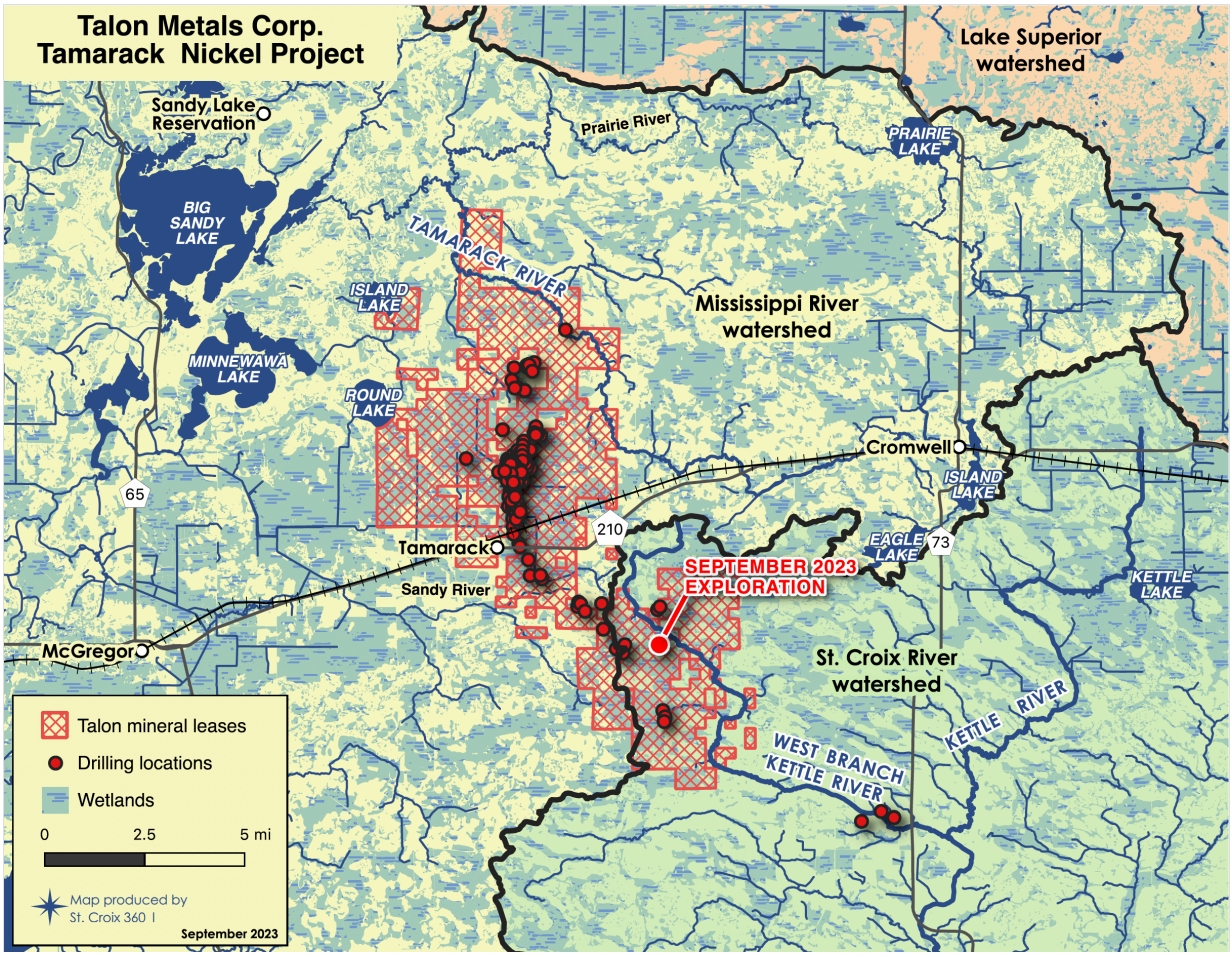
Chemistry
Geochemistry of potential overburden, waste rock, and tailings must be developed to analyze all relevant parameters, including: 1) metals known to affect aquatic life, wildlife, and human health, such as aluminum, arsenic, chromium, cobalt, copper, lead, manganese, mercury, nickel, zinc; 2) other harmful parameters, such as nitrate, sulfate, chloride, asbestiform minerals (especially serpentine group fibers); and 3) specific conductivity known to affect aquatic life, wildlife, and human health either directly or through chemical reactions.

The chemical parameters and sampling rationale found in the *Water Quality Characterization of The Copper-Nickel Water Quality Research Area* (Thingvold, 1979) remain relevant, although substantial scientific research as to the toxicity and chemical reactivity of various parameters has been conducted since then. Potential effects on air and water of Tamarack Intrusive Complex chemistry should be tested in carefully designed laboratory and field studies as well as compared to real world experience with mining of similar deposits.

Chemical sampling of groundwater, public and private well water, surface waters, and wetlands should also be required, identifying baseline levels of all metals and non-metallic parameters that may affect aquatic life, wildlife, or human health. Samples of lakes must be taken at various depths to identify stratification conditions. In lakes, streams, and wetlands, sediment cores as well as water should be sampled for sulfate, sulfide, chloride, nitrate, nitrite, phosphorus, ammonia, mercury, methylmercury, and other relevant metals such as nickel. Sampling should be prioritized to evaluate mercury in the water column and methylmercury in fish tissue in all Tamarack Intrusive Complex regional waters. The degree to which affected areas have the potential for nutrient and mercury release from sediments and mercury methylation should be analyzed.

Sampling of air chemistry should be sufficient to identify baseline levels of inhalable particulates (PM2.5) and speciated particulates, including ammonium, black carbon, metals,

hazardous air pollutants, asbestiform minerals, and any chemicals that may be released due to mining activities. Monitoring should provide sufficient data to accurately model wind patterns and potential impacts of releases on nearby wetlands, waters, and lands as well as regional airsheds, and ultimately their impacts on human health.



St. Croix 360 Map, Talon Metals Corp. Tamarack Nickel Project, Mineral Leases, Drilling Locations and Wetlands (Sept. 2023).

Noise and Light

Baseline ambient noise and light conditions should be documented throughout the region.

Biology

Bioassays should be performed in all regional and potentially affected surface waters (including ditches and streams as well as lakes) and wetlands to set a baseline, which will aid in addressing the current state of these waters for toxicants. When test species are available, the tests must use EPA-standardized sensitive invertebrates, vertebrates, and plants. For example, the invertebrate *Ceriodaphnia dubia* is known to be sensitive to metals and should be used as a test invertebrate for sulfide mine wastes. Aquatic biology studies must include

benthic invertebrates, fish, plants, and amphibians, identifying endangered and threatened species, species of concern, and species sensitive to specific chemicals, including but not limited to nitrate, chloride, specific conductance, sulfate, aluminum, arsenic, cobalt, copper, lead, manganese, mercury, nickel, zinc. Samples and analyses should be sufficient to provide a statistically relevant set of data on which to make decisions about which analytes must be continued or with which to compare other data.

Wetlands and peatlands should be delineated and the potential effects of carbon sequestration loss and other ecosystem losses from direct and indirect (chemical discharge, air deposition, dewatering, etc.) impacts on wetlands should be analyzed.

Wild rice should be analyzed (biomass as well as density) as well as mapped as an important and sensitive species in all water bodies throughout the Tamarack Intrusive Complex region and downstream. This analysis must be conducted over a period of years sufficient to reflect wild rice cyclicity. Other plants, waterfowl, amphibians, and wildlife must be analyzed to identify endangered and threatened species, species of concern, and sensitive species. Effects on behavior as well as toxicity of species in response to air, water, noise, vibration, and light pollution, among other impacts, must be analyzed.

Human Beings

A cumulative and independent human health risk assessment and health impact assessment should be conducted, considering impacts on workers, local residents, subsistence harvesters, and downstream and downwind communities. Data should be collected on baseline conditions and cumulative impacts on tribal and non-tribal lands, waters, airsheds, health, and culture. Exercise of treaty-reserved rights, cultural historic properties, and cultural landscapes should specifically be analyzed in a manner that provides resources to and recognizes the sovereign leadership of potentially affected tribes. Effects on local economies, the need for social services, mental health services, the equities of taxation of mining, and the protection of local and communities and taxpayers from potential liabilities should also be evaluated.

Other Areas of Mineralization

Several other areas near the Tamarack Intrusive Complex and the Midcontinent Rift were previously explored by mining companies, and some showed potential for sulfides and other mineral deposits. For example, Severson and Heine (2003) discussed the possible economic potential for sulfide deposits in the Cuyuna Iron Range, Crow Wing County, and in Glen Township, Aitkin County. Previous activities by mining companies in several other areas near the Tamarack Intrusive Complex explored the potential presence of gold and/or uranium deposits (Ojakangas and Matsch, 2001). Talon Metals has also found gold, platinum, and palladium outside what it has designated as its resource area. (Talon 2024).

In describing receipt of funds from the U.S. Department of Defense for exploratory drilling, Talon highlighted that the "Midcontinent Rift" region of Minnesota is "highly prospective for nickel sulfide deposits with potential for 'district scale' mineralization." (Talon, Sept. 2023).

Talon and other mining companies may expand their activities to explore and develop these other potential mineral deposits. This possibility emphasizes the need for a Regional Study that includes Tamarack Intrusive Complex and Midcontinent Rift areas not previously covered by the 1979 Regional Copper-Nickel Study.

Regulatory Oversight Requirements

In addition to collection of baseline data and conducting independent analytic studies, the Tamarack Region Sulfide Ore Study should consider and strengthen the tools for regulatory oversight. The 1979 Regional Copper-Nickel Study identified the need for nonferrous mining rules to provide a framework for environmental protection appropriate for sulfide ore mining. The sufficiency of existing DNR rules should be evaluated to address at least the following issues: 1) the need to require best available technology and compliance with current environmental practice for control of air pollution, water pollution, and management of sulfide ore and reactive mine wastes; and 2) the need for a project proponent to demonstrate that the technology it proposes for mining and environmental controls has been used in practice and for at least a decade in closure without resulting in pollution as defined under applicable federal, state, or tribal laws.

In addition, given today's scientific knowledge, prior to approval of permits for mining in the Tamarack Intrusive Complex, the Minnesota Pollution Control Agency (MPCA) should adopt quantitative rules that protect aquatic life, wildlife, and public health according to today's science. That new rulemaking, at a minimum, should include: 1) numeric standards limiting nitrate to protect aquatic life and human health; 2) standards limiting sulfate discharge to prevent further impairment of waters with excessive nutrients or mercury in fish or the water column; 3) numeric standards for specific conductance to protect aquatic life and wild rice; 4) air and water numeric standards controlling asbestiform minerals to protect public health; and 5) surface and groundwater numeric standards to protect public health from PFAS/PFOS, among other toxic industrial chemical releases.

Regulatory oversight practices at both the DNR and MPCA should be examined. That oversight should be designed to protect human health and the environment and to eliminate the use of variances or other forms of regulatory exemptions to compliance with environmental standards. Regulatory practices should include preferentially identifying impacts at the lower end of the food web on which larger animal life, including humans, depend as well as protecting endangered species. This effort should also consider long-term effects on air quality, water quality, ecosystem benefits, resilience to climate change, human health, recreational and subsistence hunting, fishing, and gathering wild rice, and the exercise of treaty-reserved rights. Finally, the mechanisms of both DNR and MPCA regulatory oversight should be reformed to provide independent public citizen and scientific oversight and to remove barriers that prevent accountability and transparency.

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