COMMENTS OF
NORTHEASTERN MINNESOTANS FOR WILDERNESS, CENTER FOR BIOLOGICAL DIVERSITY, EARTHJUSTICE, NATIONAL PARKS CONSERVATION ASSOCIATION, THE WILDERNESS SOCIETY, VOYAGEURS CONSERVANCY & WILDERNESS WATCH

IN SUPPORT OF

THE APPLICATION FOR WITHDRAWAL OF SUPERIOR NATIONAL FOREST LANDS & MINERALS IN THE RAINY RIVER WATERSHED, UPSTREAM OF THE BOUNDARY WATERS CANOE AREA WILDERNESS

JANUARY 19, 2022

THESE COMMENTS INCLUDE THE ACCOMPANYING LABELED THUMBDRIVE AND ITS CONTENTS.
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Executive Summary

The Boundary Waters Canoe Area Wilderness (BWCAW) is a unique state and national treasure. It is the United States' most-visited wilderness area, the largest one east of the Rockies and north of the Everglades, and the only significant lake-land wilderness in the National Wilderness Preservation System. The BWCAW is Minnesota's crown jewel, the most pristine natural area remaining in the state, and is one of the last and largest remaining forested areas in the United States where waters and ecosystems remain virtually unaffected by human industry and habitation. Its lakes and streams are some of the most beautiful and highly valued waters in Minnesota and indeed, in the country and the world. The BWCAW and Voyageurs National Park (VNP), with Quetico Provincial Park (Quetico) in Ontario, form a 2.5 million-acre international canoe country and the protected core of the Quetico-Superior ecosystem.

The water resources within the BWCAW watershed are vast and massively interconnected. The Superior National Forest, which contains the BWCAW, represents just 1.6% the acres in the National Forest System, but holds 20% of all the system's freshwater resources. The water is some of the cleanest in the nation; one can dip a cup and drink straight from the lakes.

The quality, ubiquity, interconnectedness, and naturally low acid-buffering capacity leaves these waters highly vulnerable to pollution. The outstanding ecological, recreational, cultural, and economic values of the BWCAW and VNP are irreplaceable. The BWCAW receives pure water from almost every quarter of the Rainy River-Headwaters upstream. Damage the Rainy River-Headwaters upstream, and the BWCAW and VNP will be damaged. "Any damage to this fragile and unique ecosystem of interconnected waterways would be catastrophic."[1]

The proposed withdrawal of the Rainy River-Headwaters watershed upstream from the BWCAW and VNP (Withdrawal Area) is necessary to protect this state and national treasure from sulfide-ore copper mining which, by its very nature and scale would cause significant harm and irrevocable changes to the landscape and ecosystem.[2,3] The Federal Land Policy and Management Act (FLPMA) gives the Interior Secretary broad discretion to make the proposed withdrawal of 225,378 acres of Superior National Forest land in the Rainy River Watershed.[4] Given the inherent risks of pollution associated with sulfide-ore mining, the withdrawal is amply justified and supported here as the surest means of protecting the high-quality water and air, ecosystems, wildlife and wildlife habitat, quietude, and other recreational, wilderness, and scenic and aesthetic resources of the BWCAW and its headwaters. The proposed withdrawal to increase protection of the BWCAW and its headwaters on the Superior National Forest would be a signature accomplishment of the Biden Administration and major step forward in its America the Beautiful initiative.[5]

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[1] Gov. Dayton, M.B. (2021, Dec. 1). Declaration of Mark B. Dayton, 40th Governor of the State of Minnesota
[2] *Id.*
[3] Eger, P., & Ongaro, F. (2014). *Successful Non-Ferrous Mining: Promise or reality?* [PowerPoint presentation].
[4] 43 U.S.C. §§ 1702(j), 1714.
[5] U.S. Department of Agriculture (2021, May 6). Biden-Harris Administration outlines "America the Beautiful" initiative. [Press Release]. Retrieved December 30, 2021 from https://www.usda.gov/media/press-releases/2021/05/06/biden-harris-administration-outlines-america-beautiful-initiative

The federal government and the state of Minnesota have a long history of actions taken to protect this special place. One such action was the passage of the Boundary Waters Canoe Area Wilderness Act of 1978,6 which withdrew from exploration and mining a 222,000-acre Mining Protection Area (MPA) covering Superior National Forest lands along roads approaching the Wilderness.[7] The 1978 Act directs the Forest Service to maintain high water quality in the MPA as in the BWCAW, to protect the BWCAW from harm, and to "minimiz[e] to the maximum extent possible the environmental impacts associated with mineral development affecting" the MPA and Boundary Waters.[8]

Unfortunately, however, the Rainy River Watershed upstream from the BWCAW, while not designated for mining, is nonetheless open to and at risk of the irremediable consequences of a sulfide-ore copper mining development, a worrisome gap in the BWCAW's and MPA's protection from mining in other upstream and upwind areas of the Rainy River-Headwaters. In light of what is now known about the impacts of mining sulfide ores, particularly at the scale being considered for the Rainy River-Headwaters, it has become clear that withdrawal of the upstream headwaters of the BWCAW in the Rainy River-Headwaters watershed is critical to implement the policies that the federal and state governments have long held for the BWCAW.

The U.S. Forest Service has examined the scientific evidence and determined that sulfide-ore copper mining in the Rainy River-Headwaters would pose unacceptable risks to the BWCAW, its character, and the purposes for which it was designated, the recreation experiences and other uses outside of the wilderness, and the existing amenities-based economy. This was the basis of its decision to withhold consent to the renewal of Twin Metals Minnesota's two mineral leases in 2016,[9] and the basis for the federal mineral withdrawal application in 2021.[10] We agree emphatically with that assessment and commend the U.S. Forest Service for the proposed federal mineral withdrawal.

The proposed Withdrawal Area, which as noted elsewhere is almost entirely intact and marked by outstanding natural resources, is located within the 1854 Treaty of LaPointe Ceded Territory, over which the 1854 Treaty Tribes (Grand Portage, Fond du Lac, and Bois Forte Bands of Lake Superior Chippewa) retain treaty rights.[11,12,13,14] The U.S. Department of Agriculture and U.S.

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[6] Public Law 95-495; 92 Stat. 1649

[7] Public Law 95-495 § 11(a)

[8] Public Law 95-495 § 2

[9] U.S. Forest Service (2016, Dec. 14). Letter from Tidwell, T., Chief, to Kornze, N., Director, Bureau of Land Management. U.S. Dept. of Agriculture.

[10] U.S. Forest Service (2021). Application for Withdrawal. U.S. Dept. of Agriculture

[11] Treaty with the Chippewa, 1854, 10 Stat. 1109, in Charles J. Kappler, ed., Indian Affairs- Laws & Treaties, Vol. II (Washington- Government Printing Office, 1904), Art. 1. Retrieved December 31, 2021 via: https://dc.library.okstate.edu/digital/collection/kapplers/id/29627/rec/1

[12] See 1854 Treaty of LaPointe, MN Ceded Territory Map; and see 1854 Treaty Authority's 1854 Treaty Boundary map series in the Appendix, or at: http://www.1854treatyauthority.org/management/biological-resources/fisheries/seasons.html?id=15&task=document.viewdoc

[13] Dec. 14, 2016 Letter, USDA-Forest Service to Bureau of Land Management.

[14] U.S. Forest Service (2021b). Application for Withdrawal, Superior National Forest, Cook, Lake, and Saint Louis Counties. U.S. Dept. of Agriculture, at p. 4.

Department of the Interior have a duty to protect the 1854 Treaty area including the Withdrawal Area,[15] and must engage in meaningful government-to-government consultation with the Tribes.

The Withdrawal Area upstream of the BWCAW is ~99% undeveloped. It has high biodiversity significance, serves as critical wildlife habitat, and delivers exceptionally pure water to the MPA and BWCAW downstream. Unavoidable damage to water and ecosystems in nearby proposed mining areas upstream would in turn affect wildlife and ecosystems in the Wilderness itself. The Minnesota Pollution Control Agency (MPCA) has recognized that development in headwaters results in lower quality water and aquatic habitat downstream.[16] Whether from spills or seepage from mine facilities, increased runoff from land clearing, or a major mine accident, the BWCAW *would* be affected by sulfide-ore copper mining operations in its headwaters.

The potential impacts of sulfide-ore copper mining are magnified by the number of mines being considered for the Rainy River-Headwaters. Twin Metals alone hopes to mine four deposits in the Birch Lake area – the most popular recreational area in the watershed and outside the Wilderness – one of which would extend up to the BWCAW boundary and two of which would require mining or infrastructure under Birch Lake. In addition, Twin Metals and other companies have identified mineral deposits further upstream in the Dunka area. The U.S. Forest Service and Interior Department should consider the development not just of one mine, but potentially of a new mining district encompassing five or more mines within a twenty-mile-long area, stretching from the divide at the top of the watershed to the very edge of the BWCAW. There is simply no question that the extent of mining that could follow if the first mine is permitted would impact water quality and ecosystems in the BWCAW and protected areas downstream.

A programmatic assessment of the cumulative impacts and risks associated with exploitation of the Duluth Complex – the geologic formation in which smaller mineralized zones have been found, and from which sulfide ore would be extracted – in the Rainy Rivers-Headwaters is needed before the first mine is permitted. The standard practice of assessing cumulative impacts as individual projects are proposed would result in the incremental allowance of impacts that would not have been deemed acceptable had they been considered in total before the first mine was permitted. The withdrawal study presents a crucial opportunity to ask, analyze, and answer whether this type of mining is appropriate in Minnesota's most pristine watershed.

If the U.S. Forest Service and Interior Department are going to prevent the transformation of a premier and water-rich recreation area in the headwaters of one of the most pristine watersheds in America into an industrial landscape with degraded water, now is the time to do it. The proposed mineral withdrawal covering this watershed is necessary to ensure that we do not lose another place of great enduring beauty and value to the resource extraction pressures that have already altered most of the country and world. This is particularly so where the Biden Administration has recognized the urgent need to protect and connect intact and undeveloped ecosystems in the face of catastrophic climate change.

Five primary factors make this watershed an inappropriate place for the mining of sulfide ores:

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[15] Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 65 Fed. Reg. 67249 (March 14, 2008).
[16] Minn. Pollution Control Agency (2017). *Rainy River-Headwaters Watershed Monitoring and Assessment Report.*

1. It is not possible to mine sulfide ores in the Rainy River-Headwaters Watershed without degrading water and air, both in the Birch Lake/South Kawishiwi River area and downstream and downwind in the MPA, BWCAW, Quetico, and VNP.

Incremental degradation of water quality is an inevitable consequence of mining sulfide ores. Even the mining industry acknowledges that non-degradation of water quality is not a realistic goal.[17] The water quality rules are often interpreted to allow pollution of water up to the point of exceedances of water quality standards. In the Rainy River-Headwaters watershed, which is recognized for its "immaculate"[18] water quality, that would mean up to an order of magnitude or more of common mining pollutants.

BWCAW and VNP waters have been designated as "Prohibited Outstanding Resource Value Waters," a designation that reflects the policy that no lowering of water quality is acceptable for any reason.[19] Studies of mining-influenced and other developed sites indicate that discharges to headwaters can influence water quality for many miles downstream. As all waters in the Rainy River-Headwaters flow into the BWCAW and VNP, siting a mine here is inherently problematic.

Any development of the size necessary for large-scale mining operations would result in degradation of downstream waters in this watershed. MPCA's Draft Rainy River-Headwaters Watershed Restoration and Protection Strategy (WRAPS)[20] models the potential increased load of sediment, nitrogen, and phosphorus under development, forest disturbance, and climate change scenarios that would result regardless of the reasons for development. The results provide a clear indication that any land clearing of the size that would result from mining would increase loads of these pollutants to downstream waters. This is even without consideration of the additional impacts that ensue from mining itself, the industrial activity most responsible for the release of toxic materials into the nation's environment.[21]

In addition to the pollutants modeled for the WRAPS Report, any sulfide-ore copper mining operation in the Rainy River-Headwaters would increase concentrations and loads of sulfate, mercury, other metals, and total dissolved solids in adjacent and downstream waters. Mercury in particular can harm aquatic resources, wildlife, and public health with very small increases in concentration.

Mining operations also produce large volumes of air pollution, particularly in the form of fugitive dust. Fugitive dust is a particular problem for drystack tailings facilities of the type proposed for the Twin Metals Maturi mine. sulfide-ore copper mines in the Rainy River-Headwaters would be close enough to the BWCAW and VNP that air pollution would affect the Class I airsheds, and deposition of dust and other air pollutants would affect BWCAW waters to the immediate northeast of proposed mining facilities, among other waters. Modeling done for

[17] Eger, P., & Ongaro, F. (2014).
[18] MPCA (2017, June). Rainy River-Headwaters Watershed Monitoring and Assessment Report. Exec. Summary.
[19] Minn. R. 7050.0265 subp. 7 and .0335 subp. 3.A.
[20] MPCA (2021, Aug.). *Draft Rainy River-Headwaters Watershed Restoration and Protection Strategy Report.*
[21] See Environmental Protection Agency (EPA) Toxic Release Inventory. https://www.epa.gov/toxics-release-inventory-tri-program/find-understand-and-use-tri

the state Copper Nickel Study indicated that mines in some parts of the Duluth Complex might not be permissible because of impacts to the Class I BWCAW.[22]

2. Sulfide-ore copper mining in the Rainy River-Headwaters Watershed would present unacceptable risks of substantial pollution in the Birch Lake/South Kawishiwi River area and downstream and downwind in the BWCAW, Quetico, and VNP.

In addition to incremental degradation of water quality, mining sulfide ores always presents significant risks of severe water quality standard exceedances. With the Rainy River-Headwaters' abundant, interconnected, and vulnerable surface and groundwater and related social and ecosystem values, the risks of substantial water pollution presented by sulfide-ore copper mining are not appropriate.

The risks from large-scale mining of sulfide ores cannot be completely foreclosed. No matter what precautions are taken, science and technology have not reached the point of being able to guarantee that a mine will not pollute downstream waters. Risks arise from the unknowns and uncertainties of the geochemistry and hydrogeology of a mine site, and the uncertainties relating to materials and methods used to control water. The risks stemming from uncertainties are multiplied by risks of accidents and other unforeseen events, often caused or exacerbated by human error. The enormous scale of mining operations, the amount of polluted water that must be contained and managed, and the long timeframes involved virtually guarantee that at some point, something significant will go wrong. Even Twin Metals, when asked by the StarTribune whether Twin Metals could say there's zero risk to the BWCA, responded: "That's not a fair question."[23] Hardly a response to inspire confidence, yet a rare example of mining company candor; of course it can't promise the BWCAW won't be harmed. The mining industry has not yet proven that it can operate even a very small mine without polluting water; the chances that it could operate several large mines in a landscape like that of the Rainy River-Headwaters is vanishingly small.

While all human endeavor involves risk, the risk that sulfide-ore copper mining operations pose to the environment is unmatched by any other industry. The question here is whether the Rainy River-Headwaters and BWCAW are an appropriate environment to bear such risk.

3. Sulfide-ore copper mining in the Rainy River-Headwaters watershed would result in several large contaminated waste sites spread throughout the watershed, threatening downstream waters.

Every sulfide-ore mine that intercepts groundwater leaves behind what is essentially a contaminated waste site, either as contaminated groundwater in the underground workings or backfilled pit, or as a contaminated pit lake. Unless it is pumped and treated, contaminated water will eventually make its way into surrounding groundwater. For many mines, pumping and treating will need to continue for hundreds or thousands of years. Unidentified pathways to surface water, errors in predictions of likely water quality, and failure of water containment and

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[22] Ashbrook, Peter (1979). *Impacts of fugitive dust emissions from a model copper-nickel mine and mill.* [Draft report]. Minn. Dept. of Environmental Quality.
[23] StarTribune. (2019, November 24). Editorial- Not this mine. Not this location.

collection systems often result in unanticipated impacts to surface waters. In addition, many mining operations result in contaminated groundwater below and downgradient of waste rock stockpiles, tailings disposal facilities, and processing and transport facilities. If sulfide-ore copper mining were allowed in the Rainy River-Headwaters, multiple contaminated sites would eventually be spread throughout the watershed upstream of the BWCAW.

4. Industrial-scale mining is incompatible with wilderness, nature-based recreation, and an economy that is dependent on them

It is folly to believe that industrial-scale mining and nature-based recreation can exist side-by-side on the same lake-land landscape, where sightlines, industrial noise, and air and water pollution would be unimpeded. Wilderness and nature-based recreation in the BWCAW and surrounding canoe country are dependent on a natural landscape, quiet, clean air, clean water, natural ecosystems, and presence of wildlife. Siting even one mine here, as Twin Metals has proposed, would destroy the area for its current use.

The BWCAW is cherished as a uniquely accessible wilderness oasis by hundreds of thousands of people. The Birch Lake/South Kawishiwi River area is a beloved near-wilderness scenic recreation area in its own right. Pursuant to the Boundary Waters Canoe Area Wilderness Act, the U.S. Forest Service has designated the area just upstream from the BWCAW for scenic recreation, and it is managed and used as a place where wilderness-like recreation is accessible to people using motorized as well as traditional means of travel.

In addition, because of the pristine waters, the BWCAW and Rainy River-Headwaters provide other highly important ecological values. They provide a core refuge of critical habitat for endemic wildlife species with declining populations such as moose and lynx, which in the face of climate change may be essential to the continued existence of these species in Minnesota. This is true of threatened and imperiled plant communities as well. The high quality of the area's ecosystems and the presence of wildlife are key components of wilderness character, and both would inevitably be degraded by sulfide-ore copper mining operations.

The BWCAW is at the heart of a diverse, stable and growing amenity-based regional economy. This includes supporting a large portion of the region's healthy recreation industry, and extends to retaining and attracting new residents and the construction, professional services, and retail/manufacturing jobs and income that the local population supports. The attractiveness of the BWCAW is a main reason for the region's resistance to the population declines seen in other rural and mostly-rural Minnesota counties in the last several decades. Opening the watershed to sulfide-ore copper mining would destroy wilderness-edge areas that host significant recreation businesses and activity, inject destabilizing boom-bust dynamics into the area's economy, and cause the greater Ely area a net loss in both jobs and income within a few years of a mine opening.[24] The common assumption that the addition of mining jobs would have a net positive economic effect ignores the nature of the region's existing amenity-based economy and the ubiquitous boom-and-bust nature of the mining industry.

[24] Stock, J.H. & Bradt, J.T. (2020). Analysis of proposed 20-year mineral leasing withdrawal in Superior National Forest. *Ecological Economics, 174*, 106663.

5. No industrial discharges or emissions that increase mercury in fish tissue should be permitted in the Rainy River-Headwaters Watershed.

Mercury and sulfate are likely to increase in wetlands and lakes in the Rainy River-Headwaters if sulfide-ore copper mining is permitted in the watershed. In the waters and wetlands of northeastern Minnesota, sulfate plays a key role in mercury methylation, so even slight increases of either pollutant can significantly increase the amount of methylmercury in aquatic organisms and the larger food web. Methylmercury is already present in the environment at levels affecting public health and wildlife; any industrial use that would increase those pollutants in the Rainy River-Headwaters should not be permitted.

Although this is not currently reflected in water quality standards outside the Lake Superior basin, an appropriate benchmark to protect wildlife (as determined by the U.S. EPA) is 1.3 ng/L mercury.[25] An appropriate benchmark to protect developing fetuses whose mothers eat fish is the Fond du Lac Band of Lake Superior Chippewa standard of 0.77 ng/L.[26]

No surface waters in the Rainy River-Headwaters or BWCAW have average mercury levels as low as 1.3 ng/L, much less 0.77 ng/L. According to Twin Metals data, 2018 mercury concentrations averaged as high as 6.05 ng/L in the South Kawishiwi River/Birch Lake area.[27] All of the surface waters in the area have methylmercury levels that are already above levels understood to have impacts on wildlife and human health, as reflected in the high fish tissue mercury levels in all of the lakes in the area that have been tested.

A 2011 study by the Minnesota Department of Health found that 10% of newborns in the Minnesota portion of the Lake Superior basin have blood methylmercury levels high enough to affect neurological development.[28] While a similar study has not been done of the Rainy River watershed, the geography, geology, ecology, and cultural practices of these adjacent watersheds are quite similar, and thus similar findings would be expected.

Many visitors to the BWCAW, VNP, and Quetico – including children and women of child-bearing age – rely on the fish they catch during their wilderness trip. The shore lunch/dinner is an iconic experience of the Quetico-Superior ecosystem for many people. It is unacceptable now that people should not eat the fish they catch while traveling in the Parks and Wilderness. Government allowance of sulfide-ore copper mining projects that would worsen the situation would be unconscionable.

Finally, the minerals that have been identified in the Rainy River-Headwaters are not so rare or in such short supply that we need allow degradation of one of our nation's greatest treasures to obtain them. Protecting the BWCAW and its watershed will not stand in the way of U.S.

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[25] U.S. EPA (1995a). *Great Lakes Water Quality Initiative criteria documents for the protection of wildlife* (EPA/820/B-95/008).
[26] Fond du Lac Band of Lake Superior Chippewa Ordinance 12/98, App. 1
[27] Twin Metals Minnesota (2019a), line 3056 and Table 6-7.
[28] McCann, P. (2011). *Mercury Levels in Blood from Newborns in the Lake Superior Basin.* Minnesota Department of Health.

progress in the clean energy transition. To the contrary, preserving the BWCAW and its watershed – two of the most pristine natural areas we have left – is the real investment in Minnesota's and America's future.

The Structure of This Comment Letter

The comment letter that follows is organized into five parts. **Part 1** of this letter summarizes the key scientific studies, government reports, and peer reviewed published scientific papers detailing the unique values of the proposed withdrawal area and the serious ecological, social, and economic harm that would result from sulfide-ore copper mining in the Rainy River-Headwaters. An earlier edition of Part 1 was included in comments submitted by NMW on February 28, 2018. In this Part 1, new additions are named in bold text.

Part 2 presents the benefits of the proposed withdrawal; the technical and scientific reasons for the withdrawal's necessity; the nature of the inherent risks and track record of sulfide-ore copper mining; and the types of foreseeable harm it would cause to the ecological, social, cultural, and economic resources and values of the Withdrawal Area, MPA, BWCAW, and other areas downwind and downstream, absent the proposed withdrawal.

Part 3 speaks to the scope of review and alternatives. It is essential that this programmatic-level review address the threshold question of whether the unique, intact, water-rich, and vulnerable Rainy River-Headwaters watershed, upstream from the BWCAW, is the wrong place to consider an activity as risky, polluting, and regionally untested as sulfide-ore copper mining. The programmatic review should consider the negative effects of the proposed Twin Metals Maturi mine project, and the potential cumulative degradation from more extensive sulfide-ore copper mining in the watershed, which might eventually occur in the absence of the proposed withdrawal.

Part 4 addresses policy considerations that may bear on the environmental review and decision regarding the proposed mineral withdrawal. These include how the withdrawal would be a significant contribution toward the Biden-Harris Administration's "America the Beautiful" commitment to conserve 30% of the nation's lands and waters by 2030 and honor the long history of state and federal protection for the BWCAW, the joint protection by the U.S.-Canada of the Quetico-Superior region, and the Boundary Waters Treaty of 1909, in which both nations agreed not to pollute waters that flow across the border. Part 4 also addresses the strong support for the withdrawal among Minnesota political leaders, and with the public nationally and in Minnesota; and how the withdrawal, as with the sole mine currently proposed for the area, is irrelevant to and has no effect on the U.S. clean energy transition, since the mine – if it were ever built, many years in the future – would produce insignificant quantities of minerals in relation to U.S. apparent consumption, and in any event has said it would ship those minerals out of the out of the country in the form of metal concentrates to be smelted and refined overseas, most likely in China.

Part 5 addresses the requirements of the Federal Land Policy & Management Act (FLPMA), the National Environmental Policy Act (NEPA), the National Forest Management Act (NFMA), the Wilderness Act of 1964, the Boundary Waters Canoe Area Wilderness Act of 1978, the

Endangered Species Act, Clean Water Act, Clean Air Act, and other relevant laws. The proposed withdrawal is consistent with and supported by those laws. Given the significant public interest and potential impacts associated with this high-profile federal action, it is crucial that the U.S. Forest Service, as the lead agency, and BLM, as a cooperating agency, ensure robust yet efficient analysis under NEPA. Part 5 also rebuts selected assertions made in past scoping comments of Twin Metals Minnesota and its law firm, Dorsey & Whitney, LLC.

Electronic copies of this comment letter and the materials cited in it are contained on a tagged and labeled companion thumbdrive. Hardcopies of this comment letter, along with a copy of the companion thumbdrive, are delivered by FedEx to the BLM, care of F. David Radford, Deputy State Director of Geospatial Services, at the BLM Eastern States Office, 5275 Leesburg Pike, Falls Church VA 22041; and in person to the U.S. Forest Service, care of Connie Cummins, Superior National Forest Supervisor, 8901 Grand Place, Duluth, MN 55808-1122. Please direct any inquiries to Matt Norton, Science and Policy Director, Campaign to Save the Boundary Waters, at matt@savetheboundarywaters.org.

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PART 1: SUMMARIES OF SCIENTIFIC REPORTS

The Forest Service should consider the following important reports and data, and the issues raised therein that explain how sulfide-ore copper mining threatens aquatic and terrestrial ecosystems, public uses and social values, and cultural resources and values of the Withdrawal Area, as well as the economy of the Arrowhead Region of Minnesota and beyond. The report summaries below are organized by general topic area. **New reports (post-February 28, 2018) and those that have been peer-reviewed and published have the full citation provided in bold text.** Report copies may be found in the Appendix.

A. Predicted ecological impacts to the Boundary Waters region of sulfide-ore copper mining

Myers, T. (2013). Technical Memorandum- Twin Metals Mining and the Boundary Waters Canoe Area Wilderness, Risk Assessment for Underground Metals Mining.

Dr. Tom Myers, Ph.D., describes how sulfide-ore copper mining threatens irreparable harm to priceless northern forest ecosystems (Parentheticals explain why the facts are significant):

- Waters that would receive acid mine drainage (AMD) are currently of extremely high quality (therefore, pollution caused by mining would degrade an increasingly rare resource).
- The waters that would receive AMD contain few base compounds (therefore, natural buffering of AMD will be extremely low).
- The many streams, wetlands, lakes and aquifers downstream of the mine sites are massively interconnected (damage from AMD will be widespread and uncontrollable).
- Mine sites lie in close proximity to these water resources (therefore, preventing AMD from entering the waters would be impossible).
- The high probability of AMD coming from the mine sites, waste rock piles, and tailings pond failures (no practical possibility exists of preventing air, rainwater and snowmelt from reaching sulfide-bearing rock).
- The difficulty of predicting when and where AMD may occur because of the nature of cracks and faults in the bedrock (therefore, no practical possibility exists of effectively blocking AMD movement through the ground).
- The potential that AMD could impact waters far downstream from the mine sites (therefore, major waterways of the Boundary Waters Canoe Area Wilderness, Quetico Provincial Park and Voyageurs National Park would be threatened).
- The high cost and low probability of remediating AMD when it occurs.
- River discharge and aquifer recharge are highly seasonal, with the bulk of it occurring between mid-April and mid-June (therefore, drawdowns of surface water and groundwater by mining activity outside that period of higher flows will deplete water available in the affected ecosystems at times when the flows are already at annual or decadal low points).

Myers, T. (2014). Technical Memorandum- Twin Metals Mining and the Boundary Waters Canoe Area Wilderness, Risk Assessment for Underground Metals Mining.

Dr. Myers explains a model for the Rainy Headwaters that shows the flow of ground and surface water and the transport of contaminants. The Rainy Headwaters includes the South

Kawishiwi R., Birch Lake, and Stony River watersheds. The purpose of the model is to estimate pathways and rates for contaminants to reach the Boundary Waters Canoe Area Wilderness if sulfide-ore copper mining occurs within these watersheds. The model can be used to estimate the risk of mine spills and leaks affecting the Boundary Waters Canoe Area Wilderness and the lakes and rivers between the proposed mines and the Wilderness. Dr. Myers models three scenarios for underground mines and a proposed concentration facility in the South Kawishiwi and Birch Lake watersheds based on the Twin Metals Minnesota Pre-Feasibility Study.

- First scenario: a release of a conservative pollutant (sulfate) from five locations in underground mines using a realistic concentration of sulfate for closed and flooded underground mines in the Duluth Complex and a low discharge rate.
- Second scenario: a one-year release to groundwater from mine waste stored on the surface in the watershed, representing a range of releases that can occur.
- Third scenario: a mid-level spill at the Maturi mine site and at the proposed concentration facility site.
- Scenarios one and two (releases) show that substantial contaminant loads from leaks typical of sulfide-ore mining could impact waters that drain into the Boundary Waters Canoe Area Wilderness.
    - Once started, leaks would continue for decades (even a short-term spill would take years or decades to travel through groundwater) and would thus likely coincide with low flow periods and could create devastating impacts.
    - Contaminants entering the rivers and lakes during low flow conditions have a high potential to impact water in the Boundary Waters Canoe Area Wilderness.
    - Historically, it has been almost impossible to stop leaks at similar mines.
    - Leaks would have a significant impact on streams, rivers, wetlands, rivers and other waters adjacent to the sulfide-ore copper mine sites and in the Superior National Forest.
    - Pollution from sulfide-ore copper mines in these areas would extend into the Boundary Waters Canoe Area Wilderness.
- Scenario three (a spill at the proposed concentration plant) could devastate adjoining lakes, rivers and streams in the Superior National Forest.
- A spill could have a devastating impact on the Boundary Waters Canoe Area Wilderness, depending on level of toxicity, load and location.
- "If the sulfide mines are developed in the Rainy Headwaters, it is not a question of whether, but when, a leak will occur that will have major impacts on the water quality of the Boundary Waters Canoe Area Wilderness."

Myers, T. (2015). Technical Memorandum- Potential Metals Mining and the Voyageurs National Park, Risk Assessment for Upstream Metals Mining.

Dr. Myers extends his analysis to consider the risks posed to Voyageurs National Park from the development of metallic mineral leases in the watersheds draining to and through it, including the Rainy Headwaters, Vermillion Lake, and Rainy River-Rainy Lake Watersheds. In his 2015 "Technical Memorandum: Potential Metals Mining and the Voyageurs National Park Risk Assessment for Upstream Metals Mining" prepared for the Voyageurs National Park Association and National Parks Conservation Association," Dr. Myers reported:

- Streams draining toward Voyageurs National Park have high water quality and would be affected by small amounts of contamination for a long time.

- The low buffering capacity of the rivers in the Rainy Headwaters watershed could allow contamination from mining waste to be transported a long distance downstream, including to Voyageurs National Park.
- Contaminant seepage into groundwater could last for decades, and there would be little chance of preventing the pollution from reaching Voyageurs National Park.
- Mercury contamination is already present in Voyageurs National Park, and AMD seepage over a long time period would likely exacerbate the existing mercury problem.
- A spill in the Vermilion watershed could pose critical threats to Voyageurs National Park, especially if the waste flowed through Vermilion Lake instead of mixing.
- Discharge or leaking of high salinity water resulting from mine dewatering could ruin nearby streams and increase total dissolved solids from the Kawishiwi River to Voyageurs National Park.
- Development of tailings impoundments presents a large risk to Voyageurs National Park, especially considering their proximity to the river system, the need for a tailings impoundment to not fail forever, the connectivity of the surface waters in the watershed and increases in extreme weather events due to climate change.

Myers, T. (2016a). Acid Mine Drainage Risks - A Modeling Approach to Siting Mine Facilities in Northern Minnesota USA. *J. Hydrology*, 533, 277–90.

Dr. Myers condenses his numerical hydrological model in the peer-reviewed Journal of Hydrology. In the paper, published in February, 2016, Dr. Myers demonstrates that:

- Groundwater with substantial contaminant concentrations would discharge to streams whether sourced from deep underground or on the ground surface.
- Even relatively short-term leaks on the surface could cause substantial loads of pollutants to reach the rivers and valuable downstream resources. Underground leaks have lower discharge concentrations but continue for long time periods, such that contamination may not be obvious until after a mine closes and impacts can continue for hundreds of years.
- Longer-term leaks could cause peak concentrations reaching the rivers to be much higher than simulated.
- Releases trending southwest to northeast in the Birch Lake area would discharge to surface water relatively quickly.
- Releases in the headwaters of the Stony River would discharge to nearby surface water.
- Under the course of normal operations, proposed mines near the Boundary Waters Canoe Area Wilderness could cause significant damage to rivers and the Boundary Waters due to leaks to surface waters or substantial groundwater contamination.

Myers, T. (2016b). Technical Memorandum- Twin Metals Mine and the Peter Mitchell Pit, simulation of the development of the Peter Mitchell Pit and its effects on the proposed Twin Metals tailings impoundment.

Dr. Myers develops and applies a numerical groundwater model to assess the relationship between the proposed Twin Metals Minnesota tailings storage facility (at the originally proposed location) and the management and closure of the Peter Mitchell Pit, a series of taconite mine pits that have substantial effect on the local groundwater system. The Laurentian Divide, the boundary separating the Boundary Waters Canoe Area Wilderness and Lake Superior watersheds, naturally and originally ran across what is now the location of the Peter Mitchell Pit. A summary of Dr. Myers findings from the modelling includes:

- Removal of bedrock pillars separating the Lake Superior and Boundary Waters Canoe Area Wilderness watersheds during mining prior to closure of the Peter Mitchell Pit will essentially move the watershed boundary for a period of time.
- Heavily contaminated seepage from the originally-proposed Twin Metals tailings storage facility would flow from the tailings facility through the bedrock and into the Peter Mitchell Pit for a period of 25-50 years, and thus into the Boundary Waters Canoe Area Wilderness watershed.

Myers, T. (2018). Technical Memorandum- Twin Metals Mining and the Boundary Waters Canoe Area Wilderness, Identifying Flow Pathways.

Dr. Myers' report of February 2018 describes the numerous available pathways through bedrock and surficial aquifers for mining contaminants to reach surface waters in the watershed of the Boundary Waters Canoe Area Wilderness and the methods to estimate or map pathways. His report concludes with a qualitative risk assessment of transport of pollution to the Boundary Waters Canoe Area Wilderness and documents the evidence that groundwater pathways exist to transport pollution into the Wilderness. His report refutes claims that geophysical analysis and video of boreholes can be determinative for location and connectivity of fractures that could transport contaminants into surface waters.

- "The conclusion is that mining in the Rainy headwaters presents a substantial risk to water quality in the BWCAW. The risk is from spills on the surface, leaks from the surface storage of waste, even temporary stockpiles, and from seepage through buried waste. Geophysical analyses of boreholes cannot provide evidence of a lack of connectivity through bedrock to the surface. It is not possible for video of boreholes to show the length of fractures to show their lack of connectivity."

Baker, L.A. (2013). Potential Ecological Impacts of the Twin Metals Mine. Prepared for Northeastern Minnesotans for Wilderness.

Dr. Larry A. Baker, Ph.D., summarizes what is known about water quality, the watershed, and sulfide-ore copper mining, and states the following conclusions, among others:

- "The potential impacts of the mine are high because this is a very large mine located in an ecologically sensitive area."
- Fish in these waters are sensitive to acidification; even small changes in pH caused by AMD would result in losses of species. If pH were to decline below 5.0 most species would be lost.
- Leaching of heavy metals associated with AMD impairs fish and other aquatic life.
- Because wild rice is harmed or destroyed by sulfate levels greater than 10 mg/L, and because background sulfate levels in these waters are around 6 mg/L, elevated sulfate levels associated with sulfide-ore copper mining would likely impair wild rice production. It may also harm other rooted aquatic plants.
- Sulfates are a factor in the creation of methyl mercury, which is the form of mercury taken up in the food chain. The increased methylation would increase the concentrations of mercury in fish and thus expose human and other consumers of fish to the risks associated with elevated levels of mercury in their bodies.
- AMD input and elevated sulfate levels would affect the natural cycling of phosphorus between sediments and waters. The release of phosphorus to waters would cause increased algal growth, loss of water clarity and eutrophication.

- AMD and associated contamination may affect a large number of shallow, easily contaminated domestic drinking wells in the area.
- Tailings dam failures, because of an extreme weather event, human error or other reason, pose a serious risk to downstream ecosystems; the downstream distribution of acidic water and sediments contaminated with heavy metals would pollute many kilometers of waters. Damage from metal-laden sediments would persist for years.

Dr. Baker later extended his analysis to address the effects of AMD pollution at the Twin Metals mine site, the impacts of water usage by the mine during 7Q10 low-flows, and the confounding influence of climate change on mine impacts. He found:

- A mixing model based on observations and studies of realistic AMD generation potential would result in elevated sulfate levels "well above" Minnesota's 10 mg/liter wild rice standard and likely accelerate mercury methylation in sediments.
- Water withdrawal for copper production is projected by company documents to be 0.8 million gallons per day; water usage in Ely is estimated to be about 0.94 million gallons per day for comparison. Water usage for sulfide-ore copper mining could reduce the decadal low flow of the South Kawishiwi River by 7-13%.
- Water usage, energy usage and tailings productions per unit copper produced would increase over the life of a Twin Metals mine.
- Climate change will make it even more difficult to predict impacts, especially those triggered by more extreme precipitation events that threaten mine infrastructure like tailings dams, process ponds and tailings pipelines.

Engstrom, D.R. (2017, August 11). Scoping Comment on N. MN Federal Mineral Withdrawal. Dr. Daniel R. Engstrom, Ph.D., is one of the lead scientists studying the effects of sulfate on mercury cycling, wild rice, and sulfur biogeochemistry in Minnesota. In his comment letter to the Forest Service, Dr. Engstrom describes the risk of sulfide-ore copper mining to the Boundary Waters Canoe Area Wilderness and concludes:

> "The BWCAW is classified as 'outstanding resource value water' under the Minnesota statutes (MAR 7050.0180), whereby: 'The agency [MPCA] recognizes that the maintenance of existing high quality in some waters of outstanding resource value to the state is essential to their function as exceptional recreational, cultural, aesthetic, or scientific resources. To preserve the value of these special waters, the agency will prohibit or stringently control new or expanded discharges from either point or nonpoint sources to outstanding resource value waters.' (MAR 7050.0180 Subpart 1). Given the abundant evidence…that sulfate releases from mining operations through the Kawishiwi watershed and into the BWCAW pose substantial environmental risk to these outstanding resource value waters, it is scientifically prudent that mining leases held by Twin Metals and other mining interests be withdrawn by the Secretary of the Interior for a 20-year term as requested by the Forest Service."

The Minnesota Pollution Control Agency's Wild Rice Sulfate Study produced peer-reviewed papers published in late 2017. They include the following four published papers:

Myrbo, A., Swain, E.B., Johnson, N.W., Engstrom, D.R., Pastor, J., Dewey, B., & Peters, E.B. (2017a). Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction. *Journal of Geophysical Research: Biogeosciences*, 122.

Myrbo, et al., make these key points:

- Sulfate addition increased organic matter mineralization in wetland sediment, releasing C, N, P, and Hg to the water column.
- Sulfate reduction caused not only higher total mercury concentrations in the surface water, but also methylated a higher proportion of that mercury to methyl-mercury, "the only form of mercury that contaminates fish."
- Increased sulfate loading to freshwaters can cause deleterious effects separate from direct sulfide toxicity to organisms.

Myrbo, A., Swain, E. B., Engstrom, D. R., Coleman Wasik, J., Brenner, J., Dykhuizen Shore, M., Peters, E.B, & Blaha, G. (2017b). Sulfide generated by sulfate reduction is a primary controller of occurrence of wild rice in shallow aquatic ecosystems. *Journal of Geophysical Research: Biogeosciences*, 122.

Myrbo, et al., make these key points:

- Sulfate loading to freshwater ecosystems may alter aquatic plant communities when sulfate is reduced to sulfide in the anoxic rooting zone.
- The occurrence of self-sustaining wild rice populations is mainly controlled by pore water sulfide concentrations.
- Even if pore water sulfide is low, wild rice is less likely to be found if the surface water is turbid or warm.

Pastor, J., Dewey, B., Johnson, N.W., Swain, E.B., Monson, P., Peters, E.B., Myrbo, A. (2017). Effects of sulfate and sulfide on the life cycle of Zizania palustris in hydroponic and mesocosm experiments. *Ecological Applications,* 27_1 321-336.

Pastor, et al., make these findings:

- In hydroponic solutions, sulfate had no effect on seed germination or juvenile seedling growth and development, but sulfide greatly reduced juvenile seedling growth and development at concentrations greater than 320 ug/L.
- In outdoor mesocosms, sulfate additions to overlying water increased sulfide production in sediments. Wild rice seedling emergence, seedling survival, biomass growth, viable seed production, and seed mass all declined with sulfate additions and hence sulfide concentrations in sediment. These declines grew steeper during the course of the 5-year mesocosm experiment and wild rice populations became extinct with concentrations of 250 mg SO4/L or greater in the overlying water.
- Iron sulfate precipitated on the roots of wild rice plants, and may impede nutrient uptake and be partly responsible for reduced seed production and viability.

Pollman, C.D., Swain, E.B., Bael, D, Myrbo, A., Monson, P., Dykhuizen Shore, M. (2017). The evolution of sulfide in shallow aquatic ecosystem sediments, an analysis of the roles of sulfate, organic carbon, and iron and feedback constraints using structural equation modeling. *Journal of Geophysical Research- Biogeosciences*, 122. https://doi.org/10.10022017JG003788.

Pollman, et al., make these key points:

- Factors controlling pore water sulfide, which can be toxic to wild rice, where identified with structural equation modeling.
- Structural equation modeling was used to quantify the relative effects of sulfate, iron, and TOC on pore water sulfide concentrations.
- The concentration of pore water sulfide is controlled nearly equally by sulfate in surface water and sediment organic carbon and iron.

Venturelli, P., & Vondracek, B. (2017). The fish and fisheries of the Boundary Waters Canoe Area Wilderness and Voyageurs National Park, and their vulnerability to copper sulfide ore mining.

Drs. Venturelli and Vondracek describe the fish and fisheries of the Boundary Waters Canoe Area Wilderness and Voyageurs National Park, and their vulnerability to copper sulfide mining. Important points include:

- The Boundary Waters Canoe Area Wilderness and Voyageurs National Park support important, healthy recreational and subsistence fisheries with high species and genetic strain richness, which are a direct result of past efforts to maintain the pristine nature and ecological integrity of the region;
- A comparison of fish catches inside and outside of the Boundary Waters Canoe Area Wilderness and Voyageurs National Park suggests that anglers target the Boundary Waters Canoe Area Wilderness and Voyageurs National Park when fishing for lake trout (and other prized cold-water species) and smallmouth bass. State survey data suggest that some game fish species are larger in the Boundary Waters Canoe Area Wilderness and Voyageurs National Park, probably due to relatively large lakes and pristine habitat, and low fishing pressure;
- The scientific literature indicates that acid mine drainage causes long-term declines in fish abundance, species number, and genetic diversity, and may facilitate the establishment of invasive species;
- Acid mine drainage lowers pH and exposes fish and other aquatic organisms to toxic metals (e.g., copper, cadmium, lead, mercury, nickel, and zinc), which accumulate in all major organs, impair system function, cause deformities, behavioral changes, reproductive failure, and mortality, and may render fish unfit for human consumption; and
- Evidence from previous hard rock mines demonstrates overwhelmingly that a copper-sulfide mine in the Rainy River watershed will impact fish, and that such damage is likely to extend far from the mine site and persist for centuries causing damage to a relatively pristine region of the state, and the diversity of popular and rare fishes that it supports

Frelich, L.E. (2014). Forest and terrestrial ecosystem impacts of mining.

Dr. Frelich, describes significant negative effects of sulfide-ore mining on terrestrial ecosystems of the Boundary Waters Canoe Area Wilderness and adjacent areas of the Superior National Forest. Those impacts include, among others:

- Forest fragmentation within the mining area, the effects of which would extend into the Boundary Waters Canoe Area Wilderness.
  - Forest fragmentation results in changes to both plant and wildlife communities.
  - Of particular concern are species such as fisher, pine marten and interior forest songbirds that need large tracts of unfragmented forest.
- Disruption of the intricate web of water that flows through the soil, forest roots and other organisms lying on top of bedrock throughout the Quetico-Superior ecosystem. Construction of roads, waste storage and water drawdown would repeatedly disrupt water flow and cause significant additive and cumulative impacts:
  - Interference with the interaction between forests, streams and groundwater.
  - Interference with the flow and chemistry of the water in the ecosystem, resulting in changes in decomposition and nutrient cycling, changes in balance of vegetation types and tree mortality.
  - Because of the interconnectedness of the systems, activities outside the Boundary Waters Canoe Area Wilderness would have impacts within the Wilderness.
- Dispersal of invasive plant species, which would extend beyond the actual surface disturbance from mines and transportation infrastructure.
- Dispersal of nonnative earthworms, which are present but not yet well-established in the area.
  - The movement of soils associated with mining would very likely spread nonnative earthworms to areas not currently infested.
  - Fragmentation would speed nonnative earthworms' movement across the landscape.
  - Earthworms can trigger a variety of impacts with a wide range of ecological repercussions.
- Loss of native biodiversity.
  - Soil dwelling species that have not yet been discovered, including insects, worms, bacteria and fungi, probably exist in the mining area and could be lost both within the mining footprint and beyond.
- Effects of a vast increase in traffic, including heavy truck traffic, close to the Boundary Waters Canoe Area Wilderness that mining would entail. For example, road salt is likely to cause root damage and tree death for species such as white pine, basswood, red oak, bur oak and red maple. Other impacts of roads on ecosystems and wildlife are well known.
- Changes in wildlife migration and habitat use patterns.
- Effects of windblown dust and other forms of air pollution.
- Additive and synergistic effects of mining with the effects of climate change.
  - Mining would add a significant stressor to a system that will already be stressed, perhaps beyond the point of resiliency.
- Loss to science: the Boundary Waters Canoe Area Wilderness provides a baseline for a landscape otherwise affected by logging, mining, roads, housing and other human activities.

    - "This role of wilderness and other natural areas as a scientific baseline has become critical in the last few decades, to assess the overall impacts of human activity at local, regional and global scales. Without these baselines, we are essentially 'flying blind' in our ability to manage ecosystems to provide the many types of services needed by humanity."

Frelich, L.E. (2019). Terrestrial Ecosystem Impacts of Sulfide Mining, Scope of Issues for the Boundary Waters Canoe Area Wilderness, Minnesota, USA. ***Forests*** **2019, 10, 747.**

Dr. Frelich presents the principal terrestrial effects of large-scale mining in the boreal forest, including impacts in the primary and secondary footprints of the mining areas, and how terrestrial and aquatic ecosystem linkages would propagate terrestrial impacts through aquatic systems, and vice versa. Conclusions include:

- The Boundary Waters Canoe Area Wilderness is a pristine area where zero impacts from human manipulation of the nearby environment (other than climate change) are expected in the absence of mining.
- Of the numerous identified individual and cumulative impacts from mining, "it is reasonable to state that most (25 of 39…) will impact the wilderness to some degree."
- "The living portion of the BWCAW ecosystem is like a thin membrane with many fine-scale interconnections among paths of water flow, lying on top of undulating bedrock. A large primary footprint of mining activity at the top of the watershed can cause many effects related to water flow and chemistry (including aerial deposition), that will affect everything lower in the watershed. Given the high level of linkages between aquatic and terrestrial components of the ecosystem in the BWCAW, these effects will also extend into terrestrial vegetation."

Wilson, D.C., Morin, R.S., Frelich, L.E., & Ek, A.R. (2019). Monitoring disturbance intervals in forests: a case study of increasing forest disturbance in Minnesota. ***Annals of Forest Science*** **76,78**.

The authors examine a trend of declining return intervals for disturbance events in forests, including the forests of northern Minnesota, and conclude that more frequent disturbances – not necessarily stand-replacing disturbances – are shaping Minnesota's forests. Disturbance plays a role with the direction and velocity of forest succession, and can result in successional and demographic changes across forest cover types and ecoregions. Analysis confirms that rotation intervals for seven disturbance types decreased significantly in Minnesota's northern forest between 2001 and 2014. Many disturbance types are directly or indirectly related to climate change.

Powell, R.A. (2017). Mammals and mining in sulfur-bearing rock formations in northeastern Minnesota.

Roger A. Powell, Ph.D., describes the life histories and vulnerabilities of the mammals of the Boundary Waters Region to effects of sulfide-ore copper mining. Effects of sulfide-ore copper mining on mammals of the Boundary Waters Region would result via numerous pathways, such as:

- pollution of water (all mammals drink water);
- pollution, diminishment, or eradication of aquatic vegetation on which many mammals rely as habitat, for forage, or for nutrients like sodium;

- contamination and bioaccumulation of toxic metals such as methyl-mercury in fish and in mammals that consume fish;
- the direct, indirect, and cumulative effects caused by fragmentation of terrestrial habitat required for foraging, mating, rearing, denning, and dispersal; and
- destruction of important habitats, such as mature forested habitats and mature forest-wetland complexes.

Fitzpatrick, J.W. (2017). Birds of Minnesota's BWCA and Adjacent Upstream Regions, with Comments on Conservation Implications of New Copper Mining Under Consideration

John W. Fitzpatrick, Ph.D., Executive Director, Cornell Lab of Ornithology, summarizes the outstanding bird resources of the Boundary Waters Canoe Area Wilderness and adjacent mosaic of habitats located in the Superior National Forest, immediately outside of the Boundary Waters Canoe Area Wilderness, with specific attention to those areas subject to potential copper mining. The Boundary Waters Region is very well known and popularly visited by birders worldwide, who are drawn to the area because the extremely high water quality and mosaic of habitat types in the Laurentian Mixed Forest hosts extraordinary bird species diversity. Key points raised include:

- 225 bird species regularly occur in the Superior National Forest;
- 163 of those species are documented as breeding within the Boundary Waters Canoe Area Wilderness and surrounding areas, *representing 74% of the list of bird species that regularly breed in Minnesota*;
- 60 additional bird species regularly depend on the Boundary Waters Canoe Area Wilderness and surrounding areas as stop-over sites on spring and fall migration;
- 13 of the 86 bird species identified as of significant "continental concern" by North America's two premier bird conservation consortia (Partners In Flight or PIF, and the North American Bird Conservation Initiative (NABCI)), are hosted in the Boundary Waters Region. "Every possible effort to conserve or restore their highest-quality habitats is essential for conservation of the species," and "therefore, maintaining the pristine condition of all BWCAW regional habitats" is vital to their long-term conservation.
- The coniferous forests and forest wetlands of the Boundary Waters Region support from 25% to 100% of the habitat of Minnesota's boreal-zone species, most of which are designated by PIF as "species of stewardship priority for Minnesota."
- The Boundary Waters Region supports the highest diversity of breeding wood warbler species anywhere in the world – 24 species of wood warblers, which represent 2/3 of all species breeding east of the Great Plains.
- 99 bird species depend on the Boundary Waters Region's superb aquatic habitats, 31 species for breeding, and 68 for pass-through feeding and resting during migrations.
- The common loon – the iconic state bird and bio-indicator of freshwater ecosystem health – is a top trophic-level consumer and thus highly susceptible to bioaccumulation of methylmercury and other potent heavy metal toxins. Numerous studies have shown these cause negative effects on loon physiology, feather symmetry, behavior, chick survival, and reproductive success.
- The common loon population on the Superior National Forest experienced an annual decline of 4.2% from 1995 to 2016.

- Even marginal increases in mercury methylation from mining operations could substantially impair common loon populations, and the larger community of fish-eating bird species that rely on the pristine resources of the Boundary Waters Region.

Chambers, D.M. (2014). The potential for acid mine drainage and other water quality problems at modern copper mines using state-of-the-art prevention, treatment, and mitigation methods.

Dr. Chambers reviews data and reports regarding sulfide-ore copper mining in the Duluth Complex and currently available copper mining technologies and finds:

- Most of the waste rock and pit wall rock so far studied in the Duluth Complex would contain some sulfur, mainly as the mineral pyrrhotite, a primary cause of AMD. There are essentially no acid-neutralizing carbonate minerals in the waste rock.
- Copper is particularly toxic to aquatic organisms, but current National Ambient Water Quality Criteria for Protection of Aquatic Life for copper are not totally protective of all aquatic species.
- Uncertainties based in the inherent complexity of natural materials and their environments prevent predictive ability, which prevents the conclusion that a mine will have only insignificant impacts.
- Difficulties of adjusting water treatment and seepage collection technologies to meet real-world chemical composition, geomorphology and water cycle variation are much greater than suggested by assumptions within the environmental assessment process.
- No significantly new water treatment technologies have been developed in recent decades. The most complete systems, including reverse osmosis, are highly expensive and require their own follow-up treatment systems.
- No tailings storage facility seepage collection system is perfect ("all liners leak") and disposing of tailings or waste rock in an old facility would likely use an unlined system.
- The U.S. Environmental Protection Administration has observed that mines continue to operate even if they know their treatment does not meet established water quality standards.
- Records of analogous mines indicate a high likelihood that any mine would release water exceeding its environmental permit within its lifetime.
- "It is not feasible, given today's or tomorrow's technology, to reduce the risk of impacting waters downstream from a copper/nickel mine in a sulfide ore body to zero."

Chambers, D.M. (2018a). Potential for acid mine drainage in the Duluth Complex magmatic PGE deposits.

David M. Chambers, Ph.D., P. Geop., addresses the potential for acid mine drainage caused by disturbance of the Duluth Complex magmatic PGE deposits. Key points include:

- The Duluth Complex contains disseminated metal sulfides that are proven to lead to acid generation.
- Both open pit and underground mining are possibilities for mining the disseminated copper-nickel deposits in the Duluth Complex (for example, the Spruce Road deposit will likely be an open pit mine; the Maturi and Birch Lake deposits will likely be underground mines; the Maturi SW deposit will likely begin underground and may be mined to the surface because of the location of metal minerals within 15 feet of the surface).
- Metal mining produces a large amount of waste because of the relatively small amounts of desirable metal contained in most deposits.

- Both tailings and waste rock can be sources of dissolved metal and other ionic contaminants, which affect both surface and ground waters.
- Key environmental characteristics of waste rock and tailings at the NorthMet deposit have been thoroughly studied for years; it is located in the Duluth Complex southwest of the watershed of the Boundary Waters Canoe Area Wilderness and approximately 6 miles from the Dunka Mine.
    - Most of the waste rock and pit wall rock will contain some sulfide sulfur which can produce acid leachate and soluble metals when it oxidizes.
    - There are no acid-neutralizing carbonate minerals in the waste rock.
    - Sulfide-bearing rocks may oxidize for several years before producing acidic leachate.
    - The rate of sulfide mineral oxidation in waste rock would be approximately proportional to the total sulfur content of the material and the rate could increase several-fold if the pore water were to be become acidic.
    - If pore-water pH were to shift from neutral to acidic, then the rate of sulfide mineral oxidation and associated release of metal cations (e.g., nickel and copper) would increase dramatically
    - The mechanism most responsible for the release of contaminants from waste rock and tailings is oxidation of sulfide minerals, primarily pyrrhotite ($Fe_{(1-x)}S$). The sulfide-oxidation reaction produces sulfuric acid, and releases soluble metals (e.g., cobalt, copper, iron, and nickel) that is bound in sulfide minerals. At the NorthMet deposit, secondary effects include leaching of some metals (primarily nickel and chromium) from silicate minerals, particularly where acidic pore waters increase silicate solubility.
    - Mine-related blasting and excavation dramatically increases the surface area and porosity of the rock, which allows rapid introduction of atmospheric oxygen and flushing of solutes by water. Within the pit walls and underground workings, the blasting effects increase the surface area available for oxidation for approximately 50 feet surrounding the blast holes. Water that comes into contact with pit walls and underground workings, especially after mine closure, can be expected to be contaminated.
    - Waste storage is an issue in the Duluth Complex because the terrain is relatively flat and it is difficult to find large areas where bedrock is shallow or exposed. Groundwater flow is more complicated and less restricted in both depth and area in comparison to a site located in the mountains. As a result, containing and/or collecting groundwater is more difficult and expensive.
        - Dr. Myers has shown that a tailings basin located outside the watershed of the Boundary Waters Canoe Area Wilderness in the location identified by Twin Metals Minnesota will pollute waters in the Boundary Waters watershed by way of the Peter Mitchell mine pit.
- The Dunka Mine, a taconite mine located a mile from the Twin Metals Birch Lake deposit and within 10 miles of the Maturi SW, Maturi, and Spruce Road deposits, had an over-burden of sulfide-bearing ore that was stockpiled in five waste piles approximately 40 years ago.
    - All of this sulfide-ore waste is producing acidic drainage.

    - Most of the seeps from waste rock drain into Unnamed Creek, which flows into Bob Bay of Birch Lake.
    - The Dunka pit is overflowing and drains into the Dunka River.
    - The levels of sulfate discharged from waste rock is two orders of magnitude greater than the level of background sulfate in most of the lakes and streams in the watershed.
    - The passive water treatment systems are not meeting water quality standards for nickel at three locations and the water quality standard for zinc is probably being exceeded.
- Key conclusions of Dr. Chambers:
    - The mineralization of the Maturi, Maturi SW, Birch Lake, and Spruce Road deposits, which contain sulfides at higher concentrations than the NorthMet or Dunka mine waste rock, could be expected to produce the same contaminants as at Dunka, but at higher rates and concentrations due to the higher amounts of sulfide mineralization and lower pH this waste will likely yield.
    - Like Dunka, at all of the sulfide mine developments in the Duluth Complex it is extremely likely there will be seepage from waste rock, pit walls, and tailings to ground and/or surface waters that will require treatment for elevated levels of metals, and potentially sulfate.
    - Sulfate levels of the discharges from conventional and passive water treatment systems will not be reduced, and will be two or more order of magnitudes higher than the Minnesota water quality standard for sulfate of 10 mg/L.

Chambers, D.M. (2018b). Editorial comments two reports prepared for Twin Metals Minnesota by its mining consultants, Golder Associates and Foth Infrastructure & Environment, LLC.

Dr. Chambers reviews and critiques "Twin Metals Minnesota Project – Acid Mine Drainage White Paper" by Golder Associates and "Lake of Hydrological Basis for BLM and USFS Decision to Reject Renewal of Twin Metals Minnesota's Mineral Leases and Potentially Withdraw Federal Minerals in the Rainy River Watershed" by Foth Infrastructure & Environment. 2018. Dr. Chambers notes the following:

- Golder addresses only one deposit – Maturi – and fails to address all other deposits that would be mined as underground and open pit mines.
    - As to Maturi, Golder does not address fully developed geochemical, hydrological, or mining data.
    - Backfilling of waste rock into Maturi will be limited due to a shortage of space in an underground mine.
    - At a similar underground mine, predictions that space would be adequate to store all acid generating waste rock proved wrong, and much of the waste rock is now on the surface and clearly acid generating.
    - Open pits in the Withdrawal Area will result in significant problems because of the potential to generate acid and metal contaminants.
    - In most metal deposits, iron sulfides are the most common minerals.
        - Iron sulfides have no economic value and end up in tailings and waste rock.
        - Iron sulfides are the primary source of acid mine drainage.

        - Acid mine drainage from iron sulfide waste rock can occur at rates hundreds to thousands of times that of natural weathering.
    - The possibility of unanticipated, unpredicted, results from mining must be considered when reviewing whether mining should be allowed in an area.
- Foth's basic premise is fundamentally flawed.
    - Foth fails to provide a defensible regional hydrological model that shows contamination, even if it occurred, could not negatively affect the Boundary Waters.
    - Foth criticized consideration of pre-1990 mine failures, yet failed to acknowledge numerous post-1990 mines that are causing significant environmental impacts.

Levit, S.M. (2018a). White Paper- An overview of mine facilities and issues.

Stu Levit, M.S., J.D., provides contextual information about the Duluth Complex, an overview of the inherent processes and facilities necessary at any sulfide-ore copper mining project in the Duluth Complex, and description of the types of impacts that these mining-related processes and facilities have on the landscape and the ecosystem, and concludes that the majority of mine features are predictable and many of their impacts to human health and the environment are similarly predictable.

- Almost all mines degrade onsite and offsite resources – impacting lands, natural resources, ecosystems, and ecosystem-based functions.
    - The Levit report is consistent with statements by Minnesota copper mining industry representatives: "Mining by its nature and scale causes significant changes in the landscape and ecosystem" (Minnesota Mining and Global Minerals Engineering).
- Sulfide-ore copper mining next to the Boundary Waters Canoe Area Wilderness and in the headwaters would almost certainly impact water, air, quiet, the night sky, people, and wildlife resources.
- "The BWCAW is a unique water-based wilderness area characterized by very high water quality and an extensive interconnected system of surface and ground waters. Predictable impacts, most notably to water, from mining in the Duluth Complex could significantly alter the BWCAW's natural resource and wilderness values."

Levit, S.M. (2018b). Follow-up report: Acid mine drainage and other water quality problems at modern copper mines using state-of-the-art prevention, treatment, and mitigation methods.

Stu Levit assesses current state-of-the-art mining practices and technologies and assumed current best practices to determine if it was possible to eliminate risks to water quality and other natural resource values in the immediate and downstream areas of sulfide-ore mines should they be developed next to the Boundary Waters Canoe Area Wilderness and along lakes and rivers that flow directly into the Wilderness.

- Levit concludes that it is not possible to eliminate risks to waters that flow into the Boundary Waters Canoe Area Wilderness.
- Mines create many sources of contamination that have been extensively documented and are summarized in this report.
    - Proximity to surface water and ground water is associated with higher rates of acid, heavy metals, and other contamination of those waters.

    - Financial, social, or other factors – including simple impossibility or impracticability, render mine reclamation or rehabilitation unlikely.
        - Reclamation failures are often significant sources of contamination.
        - Failure of any major component – such as a tailings impoundment or acid mine drainage formation in a waste rock pile contaminating surface and/or ground waters – is a failure of reclamation.
        - Contamination also occurs from multiple minor deficiencies (or failures) that cumulatively are capable of considerable harm.
    - Airborne contaminants from mine facilities could likely reach waters in, or that flow into, the Boundary Waters either by direct deposition to water or by being washed into surface waters or ground water.
    - Impacts from noise and light can uniquely threaten wilderness resources and values.
    - The effects of mine dewatering and ground water drawdown can be substantial, affecting hydraulic conductance/ connectivity within and between surface and shallow or deep ground water, among other impacts.
    - Water contaminant leaks have historically been shown to be almost impossible to prevent or fully clean up. Contaminants can also enter sediment and become part of a cycle of moving between sediment and the water column and move downstream during storm transport of bedload sediment.
        - Flows into and between groundwater and surface waters would make remediation particularly complex and improbable.
    - Mines in wet regions, such as the Boundary Waters Canoe Area Wilderness, are highly likely to have a spill, leak, seep, failure, unanticipated impact, human error, and/or other unintended event that results in an irrecoverable release of contaminants to ground water and/or surface waters.
        - A review of the track record of water quality impacts from sulfide-ore copper mines found severe impacts to water, contamination of farmland, contamination of water body sediments, harm to and loss of fish and wildlife and habitat, and risks to public health.
        - In some cases, acid mine drainage will generate water pollution in perpetuity.
        - Most modern copper mines are located in arid environments that have less extensive surface water resources and volumes than in the Boundary Waters Region.
        - The wet environmental of the Boundary Waters Region increases the likelihood that mines in the area will have contamination and containment problems.
            - These problems, notably water collection and treatment failures, will probably get worse after mining ends and groundwater pumps are no longer keeping the mine area/ workings dewatered.
- Levit reviewed the track record of copper mines in North America for containing contaminants and for preventing large-scale releases.
    - Project-specific reviews fail to accurately predict actual performance, and actual water quality impacts are closer to potential/ pre-mitigation impacts than to

predicted/ post-mitigation impacts (they exceed the mine's predicted pollution potential).

  - Project-specific reviews contain over-optimistic and unrealistic predictions, especially of mitigation measure efficacy.
    - Poor results occur despite mines' use of mitigation measures.
- Mitigation technologies and measures typically do not prevent pollution from occurring, particularly in situations where ground water and surface water resources are in proximity to mining-related features and infrastructure.
- Many hyped technologies are experimental, unproven, and are not proven in an environment equivalent to northeastern Minnesota.
- "The BWCAW watershed includes vast, interconnected very high quality waters. In such a watershed existing mining and mitigation techniques cannot be expected to sufficiently reduce the risks to water quality (and other resources) posed by sulfide-ore copper mining. Were mining contaminants to reach waters flowing into the BWCAW it is highly unlikely that existing mitigation measures or technologies could effectively protect water quality and/or be consistent with the BWCAW's wilderness character."

Emmons & Olivier Resources (2006). Cumulative Effects Analysis on Wildlife Habitat Loss/Fragmentation and Wildlife Travel Corridor Obstruction/Landscape Barriers in the Mesabi Iron Range and Arrowhead Regions of Minnesota.

Prepared for the Minnesota Department of Natural Resources, May 15, 2006, this report presents a cumulative effects analysis performed in 2006 for past, present, and what were at the time reasonably foreseeable actions examined the total land loss and impacts on known wildlife corridors for sensitive species in northeastern Minnesota. It found that six of the 12 known wildlife corridors in the 100-mile Mesabi Iron Range will likely become isolated, fragmented, or lost completely, and almost 9,000 acres of habitat will likely be destroyed by mining, economic development, and forestry practices.

Minnesota Environmental Quality Board (1976-1979). Minnesota Regional Copper-Nickel Study. Retrieved via: http://www.leg.state.mn.us/edocs/edocs.aspx?oclcnumber=05579755.

When Minnesota faced the first wave of interest in copper-nickel sulfide-ore mining in the 1970s, it undertook a regional-wide study of the impacts that such mining would have on northeastern Minnesota. The study was "commissioned because it was believed that conventional site-specific environmental impact statements (EIS's) and the corresponding regulatory process were inadequate to deal with the broader issues involving this unexploited resource" (Executive Summary, p. i). The resulting 5-volume, 36-chapter study details the area studied and the environmental, economic, and social impacts of copper-nickel sulfide-ore mining in the region, and is based on over 180 original technical reports conducted by Environmental Quality Board staff and other experts. Minnesota enacted a statewide moratorium on copper-nickel sulfide-ore mining while the study was completed.

Assumptions for the assessments by Dr. Myers, Dr. Baker, Dr. Frelich, Dr. Chambers, Dr. Venturelli, Dr. Vondracek, Dr. Powell, Dr. Fitzpatrick, and Mr. Levit:

- *Twin Metals Minnesota deposits would be developed in accordance with the 2014 Technical Report 43-101, Duluth Metals, Inc., with state-of-the-art methods, facilities, and management practices.*

- *Studies addressed impacts and risks that are likely to occur regardless of changes in mine plans.*

B. Predicted human health impacts and human experience and social impacts to the Boundary Waters region of sulfide-ore copper mining

Pearson, J., Ipsen, J. Sutherland, S., Wegerson, K., Onello, E. (2019). Risks and costs to human health of sulfide-ore mining near the Boundary Waters Canoe Area Wilderness. *Human & Ecol. Risk Assessment: An International Journal* https.//doi.org/10.1080/10807039.2019.1576026

The authors review the health risks and nutritional and social consequences associated with pollutants generally accompanying sulfide-ore copper mining, including particulate matter, elongated mineral fibers, heavy metals, sulfate, and methyl-mercury, and the negative impacts of the same on treaty resources of importance to tribal communities.

Onello, E., Allert, D., Bauer, S., Ipsen, J., Saracino, M., Wegerson, K., Wendland, D., & Pearson, J. (2016). Sulfide Mining and Human Health in Minnesota. Minnesota Medicine. 2016, November 51-55.

This review in Minnesota Medicine, the magazine of the Minnesota Medical Association, addresses public health perspectives on the ways in which sulfide-ore copper-nickel mining in the Duluth Complex would be distinct from and potentially more hazardous than Minnesota's traditional iron (taconite) mining. Key points addressed include:

- Sulfide-ore copper mining may affect public health through the release into the environment of amphibole fibers, fugitive dust, and heavy metals;
- Some of the heavy metals expected to be released from Duluth Complex rock include arsenic, asbestos, cadmium, lead, and mercury, which are identified by the World Health Organization as being of major public health concern;
- Mercury is already a public health threat, as the results of a Minnesota Department of Health study found (one in ten infants in Minnesota's Lake Superior region were born with unsafe amounts of mercury in their blood);
- Sulfide-ore copper mining would exacerbate mercury contamination and bioaccumulation due to the release of additional sulfate – which plays a key role in mercury methylation – into groundwater and groundwater inflows to water bodies; and
- A Health Risk Assessment and Health Impact Assessment should be part of any environmental review on the question of future sulfide-ore copper-nickel mining.

McCann, P. (2011). Mercury Levels in Blood from Newborns in the Lake Superior Basin. Minnesota Department of Health.

Patricia McCann, of the Minnesota Department of Health Division of Environmental Health presents the results of a state of Minnesota study, which found that ten percent of newborns in the Minnesota portion of the Lake Superior basin have blood methyl-mercury levels greater than 5.8 ug/L (the U.S. EPA Reference Dose for methyl-mercury), a level associated with loss of IQ. Fetal blood appears to concentrate methyl-mercury at levels 1.7 times higher than maternal blood. Fetuses, infants, and children are four to five times more vulnerable to the harmful effects of mercury.

Trasande, L., Landrigan, P.J., & Schechter, C. (2005). Public health and economic consequences of methyl mercury toxicity to the developing brain. Environmental Health Perspectives.

This paper explains that methyl mercury is a developmental neurotoxicant. Exposure results principally from consumption by pregnant women of seafood contaminated by mercury from anthropogenic (70%) and natural (30%) sources.

- Blood mercury leads to loss of IQ.
- The loss of intelligence causes diminished economic productivity that persists over the entire lifetime of affected children.
- The loss of productivity is the major economic cost of methyl-mercury toxicity and amounts to $8.7 billion annually.

Minnesota Academy of Family Physicians (2017, May 8). Minerals withdrawal comment letter to USFS & BLM.

Signers the Minnesota Academy of Family Physicians, and some 110 health professionals express concerns about human health risks posed by sulfide-ore copper mining, including:

- Sulfide-ore mining releases at least 6 of the 10 environmental toxins listed by the World Health Organization with greatest concern to human health.
- Environmental studies of sulfide-ore copper mining in the Rainy River watershed should include independent, scientifically rigorous, and comprehensive health risk assessment (HRA) and health impact assessment (HIA) for:
    - Those who live in downstream communities.
    - Those who visit the Boundary Waters Canoe Area Wilderness and surrounding communities who will be drinking downstream waters.
    - Fetuses, infants, and children, those most vulnerable to the deleterious effects of methylmercury.
    - Low-income and tribal communities who rely on hunting, fishing and gathering of wild rice and other plants for their subsistence and cultural well-being.
- The HRA and HIA should
    - Assess cumulative mercury risks, including hazard levels in bodies of water that may already be impaired for mercury in fish.
    - Assess cancer and non-cancer risks to future on-site workers.
    - Assess health risks resulting from fossil fuel combustion.
    - Assess cumulative risks of multiple chemicals.
    - Assess noise pollution to the surrounding wilderness.
- The HIA should rigorously scrutinize the social determinants of health in this sensitive and unique region of Minnesota, including
    - The cost for health care, special education, lost productivity resulting from potential human health impairments.
    - The cost and capability of increasing mental health providers in the Boundary Waters Region to meet increasing needs.
    - The cost of the potential loss of a pristine wilderness that serves as a source of mental and spiritual health not only for the local region, but for countless individuals across Minnesota and the nation.
    - The cost of potential erosion of the pristine wilderness that has sustained an outdoor recreation industry in Minnesota that contributes to a stable tax base, jobs in a range of sectors, and the retention of talent and wealth in Minnesota.

Ipsen, J., Pearson, J., Sutherland, S., & Wegerson, K. (2018, February 18). Comment letter to USFS regarding proposed mineral withdrawal.

Four physicians restate concerns regarding sulfide-ore copper mining health risks and expected degradation of air quality at and around the mine area and in a large portion of the Boundary Waters Canoe Area Wilderness, endangering on-site workers, members of nearby communities, and visitors. The harm could be insidious, potentially causing disease years after injury occurred.

- The medical professionals ask that the Mineral Withdrawal environmental review study the risks and costs of the loss of wellness that will result if communities around the Boundary Waters were to transition from communities that serve as the gateway to pristine wilderness, to communities that are a gateway to large industrial mine sites.
- The medical professionals urge that the environmental review "include not only the potential deleterious effects of sulfide-ore copper mines in this water-rich area, but also include an assessment of the benefits of the current region AS IT IS and the risks/costs of what will be lost with the development of sulfide-ore copper mines at the headwaters of the Boundary Waters. They state that a robust environmental review that includes these components will demonstrate that the Mineral Withdrawal in the Rainy River watershed is necessary to protect the health and wellness of this sensitive and special region of our state.
- The Comment Letter confirms that 30,000 health professionals have expressed grave concern about opening SNF lands in the watershed of the Boundary Waters Canoe Area Wilderness to sulfide-ore copper mining and collectively call for a HRA and a HIA.

Reyer, J. & Garwin, R. (2015). The Impacts of Mining on the Character of a Wilderness Landscape Considerations for Federal Decision-Making.

The authors pose the question "How will this change in land use affect people's life experience," noting that "[s]ome places … are so important to people's sense of what is right and good and of ultimate value that the character of the area becomes…a critical consideration in decisions about land use changes that will affect that character. The Boundary Waters Canoe Area Wilderness and the Birch Lake/ South Kawishiwi River that flow into it are such a place. To transform this area from what it is today into an industrial mining district would amount to a change in the character of a landscape that would affect the experience and psychological well-being of tens – or even hundreds – of thousands of people in a way that simply cannot be captured by a discussion of ecological and economic considerations." The authors show that:

- Changes of the nature required by mining would affect something fundamental to peoples' sense of well-being.
    - "Any government decision that allows mining to move forward in this area [South Kawishiwi River and Birch Lake] is in part a decision to sacrifice a landscape that nourishes people's souls to the most destructive industry that humans have devised."
- Industrial-scale mining is probably the single activity that has the greatest potential for impacting wilderness character when it is undertaken outside of but in close proximity to a wilderness area. There simply is no other activity that creates the amount of disturbance, noise, light pollution, traffic, human presence, and pollution in remote

locations. Mining close to a wilderness area would inevitably impact wilderness character.

- There is legal support for making this a primary consideration of any decisions that would result in a transformation of Superior National Forest lands adjacent to the Boundary Waters Canoe Area Wilderness into an industrial mining district.
    - Congress has directed the U.S. Forest Service to protect wilderness character and to protect the Boundary Waters Canoe Area Wilderness from mineral development to the maximum extent possible and has provided no countervailing directives that would provide a rationale for permitting a mine if the Boundary Waters Canoe Area Wilderness would be affected.
- There are historical examples of federal agency decisions that took similar considerations into account.
    - In Yellowstone National Park, the Grand Canyon National Park, and the Rocky Mountain Front of the Lewis & Clark National Forest decisions were made to protect the character of the landscape, even though it meant that the metal or oil found there would not be made available for human use.
- Ecological risk assessments provide a context for such considerations in a NEPA analysis
- Several inevitable impacts of industrial mining that would result in the transformation of the character of the South Kawishiwi area and would significantly impact the wilderness character of the adjacent Boundary Waters Canoe Area Wilderness.
    - Outside the Wilderness what is now a beloved recreation area would become an industrial landscape.
    - Inside the Wilderness the proximity of industrial activity would mean that this part of the wilderness area would no longer be experienced as wilderness.
- "Perhaps more than for any other wilderness in the country, American citizens have stood up again and again to fight to retain the wilderness qualities of the Boundary Waters Canoe Area Wilderness. They have done so because the BWCAW speaks to them in a way of no other place they have known. Mining on the edge of the wilderness would ensure that this part of the BWCAW would no longer bring the deep joy that so many come here to find."

Sungur, E., Asche, K., Fluegel, D., Ronnander, R., & Bibeau, J. (2014, January 2). The Four Townships Area Economic, Housing and Development Survey. Center for Small Towns & Data Services Center. University of Minnesota Morris.

The authors, all with the Center for Small Towns & Data Services Center at the University of Minnesota Morris, released a report on the survey of all property owners in the four townships surrounding Ely.

- When asked, "Why do you choose to live or own land in the four townships area?" respondents overwhelmingly highlighted natural amenities.
- Conversely, when asked what would make them leave the four townships area, respondents chose "mining," "pollution" and "overdevelopment" as the top three of four categories.
    - 23% of the respondents said they would leave the area if mining were developed.
- Likewise, the Minnesota Design Team visited Ely in 2014. They gathered 200 residents for a community visioning session to help guide Ely's future. In response to the question, "What do you love most about your community?" the common response was, "Location

near wilderness – Boundary Waters." In addition, residents surveyed saw "tech-based businesses via broadband internet" as Ely's next economic opportunity, not mining.

Minnesota Department of Health (2014). Climate Change Vulnerability Assessment 2014 - Executive Summary. MDH Minnesota Climate & Health Program, Environmental Impacts Analysis Unit. Retrieved December 18, 2021 via: https://www.health.state.mn.us/communities/environment/climate/docs/ccva_execsum.pdf

Minnesota Department of Health conducted the Minnesota Climate Change Vulnerability Assessment from 2013-2014, and this executive summary and full report presents the findings. The five climate hazards listed as primary threats to Minnesota at large include extreme heat, vector-borne diseases, flooding and flash flooding, and drought.

Minnesota Department of Health (2014). Minnesota Climate Change Vulnerability Assessment Summary. Retrieved December 18, 2021 via: https://www.health.state.mn.us/communities/environment/climate/docs/mnclimvulnsummary.

The Minnesota Dept. of Health analysis, summarized, concludes that climate change will elevate a number of health for people in St. Louis County (among others) including a mildly increased risk of extreme heat events, a moderately increased risk of harmful air pollution, and a high increase in the risk of flooding.

Minnesota Department of Health (2015). Minnesota Climate and Health Profile Report 2015. An Assessment of Climate Change Impacts on the Health & Well-Being of Minnesotans. MDH Climate & Health Program, Environmental Impacts Unit. Retrieved December 18, 2021 via: https://www.health.state.mn.us/communities/environment/climate/docs/mnprofile2015.

Minnesota Department of Health presents a comprehensive assessment of climate change effects, trends, and projections; describes how the changes are linked to potential health impacts; and the resulting burden for the state. Health hazard pathways described include air pollution, extreme heat, floods and drought, and ecosystem change-related threats to human health.

Minnesota Department of Health (2018). Planning for Climate & Health Impacts in Northeast Minnesota, Emergency Management Considerations for HSEM Region 2. Minnesota Climate & Health Program.

The Minnesota Dept. of Health Climate & Health Program reports that northeastern Minnesota can expect more precipitation overall, and for precipitation to come in fewer, larger events, with more frequent extended dry spells in between. The implications for increased fire danger are noted.

C. Predicted economic impacts to the Boundary Waters region of sulfide-ore copper mining

Stock, J.H. & Bradt, J.T. (2020). Analysis of proposed 20-year mineral leasing withdrawal in Superior National Forest. *Ecological Economics* 174 (2020) 106663.

In this peer reviewed and published study, prominent Harvard economist Professor James H. Stock compares the effects of the Forest Service's proposed 20-year mining ban near the Boundary Waters with the consequences of sulfide-ore copper mining in the Boundary Waters watershed. The conclusion: protecting public lands near the Boundary Waters generates greater long-term gain for the region (more employment and more income) than copper mining.

- The study compares two scenarios being considered by federal agencies:
  - Scenario 1 – The Boundary Waters economy continues to develop during a 20-year mining ban.
  - Scenario 2 – The mining ban does not occur, and a Twin Metals/ Antofagasta mine is developed.
- The study projects 36 employment and 72 income scenarios representing a range of employment and income effects over a 20-year period. The analysis shows that mining would likely have a negative effect on the regional economy in both employment and income due to the negative impact of mining on the recreational industry and on in-migration. The findings highlight the important of considering the long-term effects of resource extraction in natural amenity rich areas. The preponderance of the scenarios (89%) indicates fewer jobs and less income resulting from a mining project, meaning that an economy based on copper mining would significantly underperform the existing growing, sustainable economy.
- This is the only economic study to analyze the longer-term dynamic economic effects of the two options over a 20-year timeframe.

Phillips, S. & Alkire, C. (2017). Sulfide-ore copper mining and/or a sustainable Boundary Waters economy.

Spencer Phillips, Ph.D. and Carolyn Alkire, Ph.D. describe the key indicators of transition and economic growth in the diversifying and more stable modern economy that exists in the three-county Arrowhead Region, which has developed in the years since the start of mining's decline in the early 1980s. In the modern Arrowhead economy, amenity-based development has taken the place of mining as the engine of development in the region. The authors describe amenity-based development as:

> "economic activity connected to a region's scenic, recreational, environmental (clean air, clean water), and other quality-of-life assets. Amenity-based development extends far beyond the recreation and tourism industries to any good- or service-producing industry that sells homes, cars, personal or professional services, food, etc. to people who move to, or stay in, a region because of its scenic beauty, quality of life, and in the case of the Boundary Waters, unique, world-renowned recreational opportunities."

The authors further describe how a mineral withdrawal of Superior National Forest lands in the Withdrawal Area would avoid economic costs associated with actual and potential sulfide-ore copper mining that, absent the withdrawal, could proceed in the Withdrawal Area. These estimated costs include

- an annual loss of $288 million in regional spending that would otherwise support 4,490 local jobs, $76 million in residents' income, $31 million in state and local taxes, and $181 million in proprietors' income and business-to-business transactions.
- 5,066 to 22,791 lost jobs, and between $402 million and $1.6 billion in lost income in the rest of the economy if sulfide-ore copper mining suppresses or reverses growth in the

amenity-based economy that has been the backbone of the region's economy since the early 1980s.
- $344 million to $509 million in lost property value (a one-time drop in asset value) that will spur annual reductions in local property tax revenue throughout the region.

The authors also recommend a set of studies, valuations, and surveys that the U.S. Forest Service should include in the economics section of the Environmental Impact Statement. These include:
- a systemic survey of business owners and managers in all sectors to estimate the effect of potential sulfide-ore copper mining on the outlook for Minnesota, and especially the Arrowhead Region.
- a thorough, statistically valid survey of residents, visitors, vacation and second homeowners, and other stakeholders' decisions about whether to vacation, retire, locate, or stay in the region under alternative scenarios.
- a hedonic price survey of residential, commercial, and other property values in areas where similar mining operations have occurred.
- an examination of the extent to which forecasted mining employment at lower- and higher-wage positions would be available to and occupied by current Arrowhead residents.
- an evaluation of the proposed action's avoided effects on all ecosystem services (timber production, fish and game and plant foods, water for drinking, recreational opportunities as valued by impacts and benefits, and other ecosystem benefits).
- an estimate of impacts to passive-use value.

Phillips, S. (2018, February 27). Comment on Northern Minnesota Federal Minerals Withdrawal EA - Economics and the BWCA Mineral Lease Withdrawal.

In his most recent report, Dr. Phillips says that the economic benefits of the proposed Withdrawal would be significant, and that the costs of the Withdrawal are overstated.
- A new wave of automation in mining uses autonomous and remotely controlled machinery monitored by a few persons who may be located far from mining sites.
- This continuing trend means that estimates made now of the number of jobs a mine may have to offer in the future are inflated and are not likely to be local jobs for local people.
- Copper mining giant Anglo America predicts that some of its underground mines will be fully automated in five to seven years, and that the human employee of the future will only need to focus on managing the company's community relations.

Phillips, S. (2015). Boundary Waters Canoe Area - wealth generator.

Dr. Spencer Phillips characterizes the existing economy in the Boundary Waters Region, defined as the three counties surrounding the Boundary Waters Canoe Area Wilderness, and finds that the Boundary Waters is an important driver of wealth, and supports the local and regional economy. Specifically, the natural amenities of the Boundary Waters and surrounding Superior National Forest provide a critical component to a thriving rural economy, and property values increase with proximity to a wilderness area. Dr. Phillips also examines likely negative economic impacts from allowing sulfide-ore copper mining to proceed within the Boundary Waters watershed, including displacing the existing economy supported by natural amenities, tourism, forestry, and recreation. Erratic boom and bust cycles associated with mining would be costly, and would create instability in the labor markets and increase strain on public services.

Power, T.M. (2007, October). The Economic Role of Metal Mining in Minnesota, past, present, and future.

Professor Thomas M. Power, former Chair of the Economic Department of the University of Montana, investigates the economic role of metal mining in Minnesota within the context of metal mining across the country and over time. He finds that economic benefits of proposed sulfide-ore copper mining would be uncertain at best. Automation and other laborsaving technologies have greatly reduced the need for workers in new sulfide-ore mines. From 1972 to 2007, while US copper production fluctuated above and below 1.5 million metric tons, the number of copper-mining jobs dropped by 71%. Similar trends occurred in the Minnesota taconite-mining sector between 1979 and 2005, where labor productivity tripled and production declined modestly, resulting in 73% fewer Minnesota taconite-mining jobs. Employment would still have declined by 67% even if production had remained constant. Of special concern to the Boundary Waters region is Power's statement, "For adjacent communities that do not have diversified economies and rely heavily on mining, this pattern of labor-displacing technological change means regular layoffs and relatively high unemployment rates, even when high levels of production are maintained" (p. 6).

Hjerpe, E.E. (2017). Regional Economic Impacts of Boundary Waters Wilderness Visitors.

Evan E. Hjerpe, Ph.D. quantified a portion of one slice of the economy in the three-county Arrowhead region of northeastern Minnesota: spending in the three-county region by out-of-region visitors who entered the Boundary Waters Canoe Area Wilderness in the summer of 2016. The study does not address in-region wilderness goers' spending in the region, or in-region economic activity generated by those who live in the region due to the Boundary Waters, spending in non-summer months, or even summer spending by out-of-region visitors who visited resorts or cabins without entering the Wilderness in 2016. In short, this is not a complete measure of the recreation economy, or of the amenity-based economy. Nonetheless, spending in the summer of 2016 by out-of-region Wilderness visitors created nearly 1,000 full and part-time jobs in the three county Boundary Waters Region. These visitors spent nearly $57 million in the three counties, generating $77 million in economic output.

Helmberger, M. (2017, Aug. 3b). Township impact- In copper-nickel debate, we all should consider economic costs as well as gains. The Timberjay.

An economic analysis published by the Timberjay on August 3, 2017 provides an in-depth look at some of the potential economic costs associated with a proposed sulfide-ore copper mine in the Ely area. This conservative analysis is a case study of one specific mine proposal, the Twin Metals mine, and the economic impact it would have on income generated by local residents in the Ely area (Ely and the four neighboring townships). The study concludes that the opening of a Twin Metals mine could lead to an initial loss of anywhere from $22.9 million to $28.6 million in local income, a figure that will likely increase over time. This economic loss of local income would exceed any gain in local income from a Twin Metals mine.

Sun, B. (n.d.) Econometric analysis of the effect of mining on local real estate values. [PowerPoint].

An academic presentation on the results of an economic analysis measuring the negative effect of a gold mine on local real estate values in Fairfield County, South Carolina. The analysis quantifies how proximity to the "mine generally had a significantly negative impact on the values of local residential properties," with effects seen to a distance of up to 13 miles.

Hjerpe, E. & Phillips, S. (2013). A Review of 'The economic impact of ferrous and non-ferrous mining on the State of Minnesota and the Arrowhead Region.'

Two Ph.D. economists review a 2012 paper by Dr. James Skurla (hereinafter, "Skurla Report")[1] is often referenced by sulfide-ore copper mining proponents as a source for dramatic overstatements (by more than an order of magnitude) of the jobs and income that sulfide-ore copper mining would bring. The misinformation generated by this paper begins in the paper itself. As documented in the review by Drs. Hjerpe and Phillips, the Skurla Report reaches unreliable and inaccurate estimates of anticipated economic impacts based on an assumption that all mining projects then under consideration would be developed by the year 2016. Additional errors in the study include:

- "…[Failure] to adhere to a number of the most critical EIA [economic impact analysis] methods. Multiple violations of standard EIA methodology undermine all generated [economic model] results."
- Inflation of the benefits of sulfide-ore mining;
- Omission of significant long- and short-term negative environmental, economic, and fiscal impacts of sulfide-ore mining in northeastern Minnesota;
- Understatement of the contributions from other sectors of Minnesota's economy;
- Over-statement of tax impacts from existing and proposed mining in Minnesota;
- Under-statement of tax breaks and tax kick-backs to the mining industry in Minnesota;
    - "[T]he mining industry is afforded minimal taxation by the State of Minnesota (an effective regional tax rate of less than one percent (<1%) of calculated direct output;"
    - "[A] substantial portion of the taxes collected are reinvested back into the mining industry;" and
- Gross overstatement of mining's share of Minnesota's GRP;
    - The study represented mining's share as 5.3% of GRP. In fact, it is 0.3%;
    - "This is a major discrepancy, and leads to a vast inflation of mining's importance."

Finally, the job increases projected in the Skurla Report were to be realized by 2016 (instead of the large projected increase, the number of mining jobs declined). Over 90% of the projected job gains were to be in the taconite industry; less than 10% were projected for the copper industry.

D. Performance record of hardrock mining and potential impacts to the Boundary Waters region

Save the Boundary Waters (2020, February 5). Four Polluting Mines Admired by Twin Metals. Northeastern Minnesotans for Wilderness.

In 2019 when Twin Metals announced it would use a filtered tailings system for its tailings pile, it said that so-called "dry-stacking" had "been successfully used in four mines in the northern United States and Canada with similar climates to Minnesota." When asked which mines it was referring to, Twin Metals said Green's Creek and Pogo, two mines in Alaska, and

[1] Not included in the Appendix.

Raglan and Éleonore, two mines in northern Quebec. All four of those mines are in operation, and all four have polluted and likely continue to pollute their surroundings today. This factsheet details some of the pollution problems, with links to source materials including regulatory agency reports, company monitoring reports, environmental review documents, SEC filings, and industry trade journals.

Gestring, B. (2020, March). Alaska Metal Mines - The track record of impacts to land and water from the failure to capture and treat mine pollution. Earthworks Report.

The author presents detailed information on pollution events at five mines in Alaska, including the Green's Creek and Pogo mines, which Twin Metals cited as mines that, in its view, had used dry-stacking successfully.

Gestring, B. (2019). U.S. Operating Copper Mines- Failure to Capture & Treat Wastewater. Earthworks.

In this 2019 update to its original 2012 report (see below), the Earthworks author, Bonnie Gestring, examines available records reflecting the performance of 15 copper mines in the United States, the combined output of which represented essentially all (99%) of U.S. copper production in 2015, and finds that **14 of the 15 top U.S. copper mines (93%) failed to capture and control wastewater, resulting in significant water quality impacts.** The unauthorized mine wastewater releases occurred in the form of uncontrolled seepage from tailings dumps, waste rock piles, open pits, failures of water treatment facilities, pipeline ruptures or other failures, and accidental releases. ***N.B.*:** reporting requirements are such that the lack of documentation of failures at the remaining mine cannot be asserted as evidence of a lack of pollution.

Gestring, B. (2012). U.S. Copper porphyry mines: the track record of water quality impacts resulting from pipeline spills, tailings failures and water collection and treatment failures. Earthworks.

This 2012 Earthworks report summarizes the performance of 14 of the 16 major U.S. copper mines operating in the U.S. (two of the 16 mines had not been operating at least five years, and thus had insufficient operating record for the review). The report found:

- Of fourteen sulfide-ore copper mines representing 89% of U.S. copper production found that 100% of the mines studied had experienced pipeline spills or other accidental releases, and 92% (13 of 14) had experienced water collection and treatment failures resulting in significant effects on water quality.
- Leaks occur at all mines.
- Although the likelihood of a particular type of leak cannot be predetermined (and this is true even with a detailed, comprehensive mine plan), the probability of some type of leak is high.

Minnesota Dept. of Natural Resources (MDNR) (2018, Nov. 1). NorthMet Project Dam Safety Permits, Findings of Fact, Conclusions, and Order of Commissioner.

The Minnesota DNR, in its Findings of Fact on the PolyMet NorthMet project dam safety permit, at findings of fact ## 209 to 220, explains that filtered tailings piles, also known as "dry-stack" tailings piles, are not appropriate for Minnesota's environment for several reasons, including the ease with which winds entrain dust from dry tailings stacks, and thus greater likelihood of significantly more fugitive dust emissions containing reactive materials, which the agency says, "could pose a significant risk to the surrounding environment." The DNR also cites the greater likelihood of oxidation and precipitation cycles, which would be more likely "to create reactive materials, including sulfuric acid. Heavy rains, snow melt, or wind could then mobilize these constituents, transporting them into nearby soils, surface waters, or other areas."

Bowker, L.N. & Chambers, D.M. (2015). The risk, public liability, and economics of tailings storage facility failures. ResearchGate.

Lindsay Newland Bowker, CPCU, ARM, and David M. Chambers, Ph.D., P. Geop., examined 100 years of tailings storage facility failures and found that despite industry assurances to the contrary, the risk of serious and very serious failures is increasing. While technological advances have allowed miners to economically recover increasingly lower grade ore, the design of storage facilities for waste rock, tailings and waste water has not kept pace with the increasing volume of waste that must be stored in perpetuity. Additionally, the tight bottom lines faced by companies extracting poor quality ore at low metal prices contributes to the challenge of maintaining tailings storage facility integrity since the techniques that reduce risk are often prohibitively expensive. Bowker and Chambers found that 49% of all recorded "serious" and "very serious" failures between 1940-2010 occurred since 1990. Included were failures at operating mines and mines in the U.S. and Europe. These failures are large enough to cause serious damage, involve loss of life, or contribute other types of significant social or economic damage, which can be non-remediable. They project that with increasing numbers of mining projects extracting increasingly low-grade ore the rate of serious or very serious tailings storage facility failures will increase, which will carry catastrophic results.

Chambers, D.M. (2015). A review of the "Report on Mount Polley tailings storage facility breach, Independent Expert Engineering Investigation and Review Panel." Center for Science in Public Participation.

Dr. Dave Chambers of the Center for Science in Public Participation reviewed the report on the 2014 tailings storage facility failure at the Mount Polley copper mine. Dr. Chambers summarized the causes of the dam failure and the ineffective monitoring technologies that failed to warn anyone that a catastrophic failure was about to occur. Dr. Chambers also emphasizes the panel's conclusion that the industry must work toward a goal of zero tailings dam failures, which is not currently the industry's goal.

Chambers, D.M., & Higman, B. (2011). Long Term Risks of Tailings Dam Failure.

This report describes the high risks of long-term storage of tailings using large dams, since they must remain intact forever, and yet have a higher incidence of failure than water reservoir dams. The authors argue that since technology and science have limits, policy makers should use a more conservative approach to making decisions about long-term risk than currently used.

Earthworks (2013). Polluting the future How mining companies are contaminating our nation's waters in perpetuity.

This report from Earthworks documents the extent to which perpetual pollution from hard rock mining in the United States has contaminated vast amounts of the nation's fresh groundwater – an increasingly valuable and scarce essential resource. An estimated 17 to 27 billion gallons of water will be polluted by just 40 mines every year in perpetuity, and yet no open pit hard rock mine in existence today has demonstrated the ability to stop acid mine drainage once it has begun on a large scale.

Giurco, D. & Petrie, J.G. (2007). Strategies for reducing the carbon footprint of copper- new technologies, more recycling, or demand management? *Minerals Engineering* 20, 842-853. doi:10.1016/j.mineng.2007.04.014

In this peer-reviewed journal article, the authors conducted a life-cycle analysis of mined copper to estimate the copper industry's CO_2 contribution and climate change impacts. The carbon emissions from primary mined copper is expected to increase over time, due to the decreasing quality of ore and increasing amount of industrial effort and energy necessary to extract and process the ore. A case study of US copper production demonstrates the importance of improving recycling techniques and share of the copper market to reduce the industry's carbon impact.

Kuipers, J.R. & Maest, A.S. (2006). Comparison of predicted and actual water quality at hardrock mines.

The research team compared the predictions of water quality impacts from hardrock mines made during the environmental review phase to actual water quality impacts that occurred at hardrock mines once they were built. They studied a representational sample of hardrock mines subject to environmental review under the National Environmental Policy Act in order to create a comprehensive picture of the predicted versus actual water quality impacts. Of the case study mines, sixty percent caused surface water quality exceedances, and at the majority of the mines, impacts occurred despite predictions that no impacts would occur after mitigation efforts were put in place. Of the case study mines, most mines predicted no groundwater quality impacts after mitigation was in place, but impacts occurred in a majority of the cases. The effectiveness levels of mitigation measures were consistently overestimated, leading to unexpected surface water and groundwater impacts. Finally, "nearly all of the mines (8/9) that developed acid mine drainage either underestimated or ignored the potential for acid drainage in their EISs" (p. ES-8).

The research team also found that "Some mine projects are so high risk that water quality exceedances are a near certainty: those mines that are both near groundwater or surface water resources and possess an elevated potential for acid drainage or contaminant leaching.

- 85% of the mines near surface water with elevated potential for acid drainage or contaminant leaching exceeded water quality standards
- 93% of the mines near groundwater with elevated potential for acid mine drainage or contaminant leaching exceeded water quality standards
- Of the sites that did develop acid drainage, 89% predicted they would not."

"Of the 19 mines that exceeded water quality standards, the pollutants that exceeded standards were as follows:

- Toxic heavy metals such as lead, mercury, cadmium, copper, nickel or zinc exceeded standards at 63% of mines.
- Arsenic and sulfate exceeded standards at 58% of mines.
- Cyanide exceeded standards at 53% of mines."

Loechel, B., Hodgkinson, J., & Moffat, K. (2013). Climate change adaptation in Australian mining communities- comparing mining company and local government views and activities. *Climatic Change* 119(2): 465-477. doi:10.1007/s10584-013-0721-8

Future climate change impacts will increase the uncertainty around whether mining infrastructure, including tailings storage facilities and process water ponds, will retain their structural integrity over time. To avoid catastrophic failure, mining companies must plan for an uncertain future that includes increased severity and frequency of extreme weather events. This study surveyed mining companies and local governments in Australia to assess the mining companies' and governments' perception of future impacts from climate change. The authors found a striking lack of concern for future impacts, "suggesting discounting of risks due to climate change skepticism." While specific to Australia, this study demonstrates how personal and industry attitudes toward climate change can increase the risk of catastrophic impacts from mines built without considering necessary adaptation techniques.

Rico, M., Benito, G., Salgueiro, A.R., D́iez-Herrero, A., & Pereira, H.G. (2008). Reported tailings dam failures: A review of the European incidences in the worldwide context. *Journal of Hazardous Materials* 152: 846-852. doi:10.1016/j.jhazmat.2007.07.050

The research team compiled records for European tailings dam failures within the context of tailings dam failures around the world in an effort to describe the distribution of tailings dam failures and identify risk factors. Out of 147 identified tailings dam failures around the world during an unspecified period of time, 57 occurred in the United States. The paper reports another index of tailings dam incidents that recorded 185 tailings dam incidents in the United States between 1917-1989, and many additional tailings dam incidents were known to occur after 1990.

Sherlock, E.J. (1995). Evaluation of Static and Kinetic Prediction Test Data and Comparison with Field Monitoring Data. (MAS thesis). Retrieved from MEND database. MEND Project 1.16.4.

This master's thesis compared methods of predicting acid mine drainage potential with actual field data for a tailings impoundment once it was developed. Sherlock found that there can be great variability in acid generation predictions, and that the predictions depend on many factors that can lead to incorrect predictions. For instance, sites predicted to have "no acid generating potential" often use short-term studies that do not consider the extended length of time material will be exposed to oxidizing conditions. In one case, it took three years of continued kinetic testing of tailings in humidity cells for acid rock drainage conditions to manifest, and many kinetic tests during environmental review processes do not allow such long-term testing.

E. Related ecological studies and potential impacts to the Boundary Waters region

Daniel, W.M., Infante, D.M., Hughes, R.M., Tsang, Y.P., Esselman, P.C., Wieferich, D., Herreman, K., Cooper, A.R., Wang, L. & W.W. Taylor (2014). Characterizing coal and mineral mines as a regional source of stress to stream fish assemblages." *Ecological Indicators* 50: 50-61.

In 2014, a team of researchers from Michigan State University, Oregon State University, the USGS Great Lakes Science Center, and the International Joint Commission Great Lakes Regional Office published a study in the peer-reviewed *Ecological Indicators* journal that showed the potential for mines to be sources of regional stress on fish assemblages (groups of fish that co-occur in an ecosystem) over large spatial scales. Daniel et al. built on an established body of research showing local negative impacts to fish habitats, fish species diversity, and fish size and survival in streams and their immediate basins in close proximity to coal and mineral mines. This team, however, broadened their inquiry to assess relationships between mine density and indicators of fish assemblage health on a regional scale, across multiple streams and catchments. While this study did not address mines in northern Minnesota, it did look at three broad ecoregions (Northern Appalachian Ecoregion, Southern Appalachian Ecoregion, and Temperate Plains Ecoregion) and showed consistent trends of negative, cumulative impact from mines to fish assemblages across all of them at the regional/multi-catchment scale.

D.C. Evers, L.J. Savoy, C.R. DeSorbo, D.E. Yates, W. Hanson, K.M. Taylor, L.S. Siegel, J.H. Cooley Jr., M.S. Bank, A. Major, K. Munney, B.F. Mower, H.S. Vogel, N. Schoch, M. Pokras, M.W. Goodale, & J. Fair (2008). Adverse effects from environmental mercury loads on breeding Common Loons. *Ecotoxicology* 17: 69-81. http://dx.doi.org/10.1007/s10646-007-0168-7

This research team studied groups of loons in New Hampshire and Maine to determine the effects of methylmercury loads on the breeding success of Common loons. They found that the loons at highest risk for environmental mercury contamination had 41% fewer fledged young than the reference group of lower risk loons, demonstrating the negative impacts methylmercury can have on loon populations.

Jennings, S.R., Neuman, D.R. & Blicker, P.S. (2008). Acid Mine Drainage and Effects on Fish Health and Ecology: A Review. Reclamation Research Group Publication, Bozeman, MT.

This review paper describes the ways that acid mine drainage (AMD) negatively affects fish health and ecology. Oxidation and hydrolysis reactions turn formerly stable minerals into toxic materials, including acid, metals (e.g., mercury, copper, cadmium, nickel, lead, arsenic, and zinc), and sulfates (react to form sulfides). Acidic conditions further catalyze these reactions, making them proceed at faster rates than would otherwise occur. AMD can affect fish populations and aquatic ecosystems both through direct toxicity and by indirect effects on the food chain and habitat availability. For instance, high acidity (low pH) can alter gill membranes and cause hypoxia among fish, and pH below 6.5 can have negative effects on fish reproductive success. Indirect effects to fish include direct toxicity to food sources (e.g., insects and other macroinvertebrates that live in streambeds), reduction of habitat, and coating of gravel beds used for spawning. Episodes of acute toxicity can kill thousands of fish in a number of minutes, as occurred in 1989 when a thunderstorm event caused enough acidification and elevated copper concentrations within 20 minutes to kill over 5,000 salmonids in Montana's Clark Fork River.

D.C. Tozer, C.M. Falconer, & D.S. Badzinksi (2013). Common Loon reproductive success in Canada: the west is best but not for long. *Aviation Conservation and Ecology* 8(1): 1. http://dx.doi.org/ 10.5751/ACE-00569-080101

This long-term study of loons in Canada emphasizes their importance at the top of the food chain, and the threats they face from methylmercury. The Common Loon is a "powerful indicator of local aquatic system health, especially in relation to mercury and acid precipitation" (p. 1). Elevated methylmercury levels create neurological and physiological problems for loons, including increased lethargy, reduced food-seeking behavior, and reduced ability to avoid predators (Tozer et al. 2013). Data collected over 18 years across Canada showed a relationship between smaller lakes with higher methylmercury exposure and low pH and reduced loon reproductive success, and the study suggested that "mercury and acid precipitation are among the most important drivers of Common Loon reproductive success in southern Canada" (p. 9).

F. Best practices for siting mines in ecologically and culturally significant areas

Hughes, R.M., Amezcua, F., Chambers, D.M., Daniel, W.M., Franks, J.S., Franzin, W., MacDonald, D., Merriam, E., Neall, G., dos Santos Pompeu, P., Reynolds, L. & C.A. Woody (2016). 2016 AFS [American Fisheries Society] Position Paper and Policy on Mining and Fossil Fuel Extraction, *Fisheries* 41-1, 12-15, DOI; 10.1080/03632415.1121742; http://dx.doiorg/10.1080/03632415.2016.1121741.

This paper recommends substantive changes in how North American governments conduct environmental assessments and permit, monitor, and regulate mine and fossil fuel development. AFS recommends that a formal environmental impact statement should be done first, and following such a study, the public should be involved in deciding whether a mine…is the most appropriate use of land and water, particularly relative to the need to preserve ecologically and culturally significant areas.

G. Failure of Minnesota to regulate mining

U.S. Environmental Protection Agency (2021, March 26). EPA letter to Minnesota Pollution Control Agency partially disapproving Minnesota 2020 List of Impaired Waters under Clean Water Act, Section 303(d).

EPA informs MPCA that it has partially disapproved Minnesota's 2020 list of impaired waters, and specifically:

> EPA disapproves Minnesota's decision not to identify certain WQLSs [water quality limited segments] for sulfate impairment because the existing and readily available data and information for those WQLSs indicate impairments for the numeric water quality criterion for sulfate. Minnesota's decision to exclude these waters is inconsistent with CWA Section 303(d) and the implementing regulations.

U.S. Environmental Protection Agency (2021, April 27). EPA Letter to Minnesota Pollution Control Agency, with Decision Document Regarding The Sulfate Impaired Waters EPA is Adding to the Minnesota 2020 Clean Water Act Section 303(d) List.

EPA and decision document identifying 30 WQLSs that EPA is adding to Minnesota's 2020 list of impaired waters. All 30 added waters are wild rice waters impaired for sulfate. EPA explains that it is starting a comment period to invite additional data.

Pugh, L. (2021, June 28). 2020-2021 Sulfate Sampling Effort for Birch Lake (69-0003-00). Northeastern Minnesotans for Wilderness.

Report on 2020-2021 water quality sampling methodology and results for sulfate in Birch Lake and key tributaries to Birch Lake, including chain-of-custody documentation and results from accredited lab. Results show that the western half of Birch Lake is impaired for sulfate.

WaterLegacy & Northeastern Minnesotans for Wilderness (2021, June 30). Comment Letter and exhibits to EPA on Minnesota Wild Rice Sulfate Impaired WQLS.

Letter presents water quality data to support the finding that a number of additional wild rice waters should be added to the Minnesota 2020 Clean Water Act, Section 303(d) list. Included among these waters is Birch Lake. More than 100 data points collected by NMW, supported by additional data points collected by the 1854 Treaty Authority, show that sulfate concentrations in the western half of Birch Lake are above 10 mg/L., due to the flows from Dunka River flowing to Dunka Bay of Birch Lake, and due to flows from Unnamed Creek flowing to Bob Bay of Birch Lake.

WaterLegacy (2015, July 2). WaterLegacy Petition for Withdrawal of Program Delegation from the State of Minnesota for NPDES Permits Related to Mining Facilities.

Minnesota is the primary authority for state water quality, charged under the Clean Water Act with issuing permits for point-source discharges of pollutants into the state's surface waters. These permits, called National Pollutant Discharge Elimination System permits, must contain discharge limits designed to maintain water quality standards set by the State. This well-documented de-delegation petition asks the EPA to remove Minnesota's delegated authority to issue permits for mining under the Clean Water Act for failure to uphold state and federal laws protecting Minnesota water quality.

- Minnesota cannot be counted on to carry out its obligations to protect Minnesota's water quality from mining facility pollution, sulfate pollution in particular.

WaterLegacy (2011, March 10). Letter to MPCA regarding Dunka AMD Seepage, with attachments (decades of agency communications regarding Dunka AMD pollution).

Documents how the Dunka Mine NPDES/SDS permit MN0042579 is deficient and inconsistent with federal and state regulations, including:

- The initial NPDES/SDS permit for the Dunka Mine (issued May, 1975) predates the USEPA's implementation recommendations to categorize permits as "major" permits based on the level and toxicity of discharge (dated June 27, 1990). Nearly 30 years after the implementation recommendations were issued, it does not appear that the Dunka Mine NPDES/SDS permit has been classified as a major discharge permit or that the USEPA has reviewed the permit for compliance with Clean Water Act requirements. The nature of metals and other toxic releases from the Dunka Mine support major permit status and greater scrutiny at both a state and federal level.
- The year 2000 NPDES/SDS permit for the Dunka Mine issued in 2000 is deficient. It does not cover all relevant pollutants and seeps as is required by the CWA. Two of the five outfalls from the mine are covered by permit variances and lack discharge standards for copper, nickel, cobalt and zinc. In addition, the permit's additive toxicity limit in the permit does not include cobalt. The NPDES/SDS permit does not set a limit for mercury, hardness or specific conductance, although discharges are likely to exceed Minnesota surface water quality standards. All of these violate the CWA.
- The NPDES/SDS permit for the Dunka Mine sets the wrong standards. For example, toxicity standards are based on high levels of hardness contributed by mine pollution, rather than according to the uncontaminated background hardness of receiving waters.
- The NPDES/SDS permit for the Dunka Mine sets toxicity limits based on the Final Acute Value (FAV), although the seven-day 10-year low flows (7Q10) for receiving waters

(Unnamed Creek and Flamingo Creek) are zero, so that toxicity should be set using a more protective Chronic Standard (CS).

- The NPDES/SDS permit for the Dunka Mine contains no limit for sulfates, which are routinely discharged at levels exceeding 1000 milligrams per liter (mg/L). Receiving waters drain into Birch Lake and the Kawishiwi River, both of which are known to contain stands of wild rice.
- The NPDES/SDS permit for the Dunka Mine expired on June 30, 2005 and has not been reissued. Variances issued more than a decade have not been subject to public review and comment. Contrary to law, the MPCA has neither required operation of the Dunka water treatment plant nor comprehensive reductions of waste stockpile infiltration to mitigate existing water quality standards violations and pollution of nearby surface and ground water.

PART 2: THE PROPOSED WITHDRAWAL IS NECESSARY TO PROTECT THE BOUNDARY WATERS AND OTHER EXCEPTIONAL AREAS DOWNSTREAM, WOULD PRESERVE EXISTING NATURAL CONDITIONS IN THE WITHDRAWAL AREA, AND HAVE A BROAD ARRAY OF RELATED BENEFITS

If sulfide-ore copper mining were to occur in the Withdrawal Area, the pollution and scale of industrial development would change and forever diminish the natural resources of the area, including the land and its ability to produce clean water. As discussed in Part 2.A.II below, water quality in the BWCAW and its headwaters, and in other similar protected areas downstream would suffer serious and irreparable degradation. Air and water pollution would harm terrestrial and aquatic resources by polluting wild rice waters and increasing mercury in fish tissue. Currently very low levels of both metals and conventional pollutants would rise. The establishment of an entirely incompatible mining district in a popular and economically important recreation area would destroy it for its current uses and cause social and economic harm in the region. The proposed action therefore is necessary to protect the Withdrawal Area, the BWCAW, and the entire unique international canoe country wilderness landscape just downstream from water, air, and other pollution and degradation.

The proposed Withdrawal would protect the ecological, physical, and other natural aspects of the Withdrawal Area and areas downstream, and yield enormous social, cultural, and economic benefits, as well. A sampling of benefits includes:

- Protection of the Withdrawal Area's water, fisheries, air quality, wildlife, and terrestrial resources from pollution and other forms of harm inherent to sulfide-ore copper mining;
- Protection of the water quality and other natural resources in the BWCA Mining Protection Area (MPA), as required by the BWCA Wilderness Act of 1978;
- Protection of the BWCAW from an unprecedented threat to its wilderness character and related values;
- Protection of the region's stable, diversified, and growing natural amenities-based economy;
- Protection of treaty resources and a large area of high-quality lands and waters within the 1854 Treaty of LaPointe Ceded Territory from degradation and permanent loss to mining;
- Maintenance of the Forest Service's ability to employ fire in the Withdrawal Area as a way to reduce the risk of future catastrophic fires, improve the condition of forest

vegetation, restore fire-related functions, processes, and habitats to the landscape, and achieve desired conditions;

- Maintenance of the Recreation Use in a Scenic Landscape management area classification of the Birch Lake/South Kawishiwi River area;
- Avoidance of public health risks from air and water pollution associated with sulfide-ore mining;
- Demonstration of the United States' commitment to honoring Article IV of the Boundary Waters Treaty of 1909, and perhaps aiding the International Joint Commission (IJC) to encourage reciprocal action or at minimum better management of problem areas and proposed mines along shared rivers (e.g., the Taku and Stikine on the Tongass National Forest, the Skagit on the Mt. Baker/Snoqualmie National Forest, the Similkameen, headwaters of the Okanagan) originating on the northern side of the U.S.-Canada border;
- Prompting the state of Minnesota to consider similar protective action;
- Alignment of federal action with public sentiment, which overwhelmingly supports banning sulfide-ore mining in the watershed to protect the BWCAW and Voyageurs National Park; and
- Maintenance of the Superior National Forest as an essential climate change migration/connectivity corridor.

The proposed action would maintain the existing natural, social, and economic conditions in the Withdrawal Area and on the Forest. The proposed action would ensure that a watershed known for the purity of water and scenic recreation in a unique lakeland landscape is not converted to an incompatible industrial use. The NEPA analysis must compare the effects of preserving current natural conditions and trends under the proposed action with the effects of reasonably foreseeable mining activity under a no action alternative. The following review synthesizes current evidence of the harms caused by sulfide-ore copper mining to integrate into the analysis and inform Forest Service and BLM decision-making. Evidence of these harms is well-enough established and amply supports a decision to move forward with the proposed Withdrawal.

A. The proposed Withdrawal is essential to protecting the BWCAW and protected areas downstream from water pollution by sulfide-ore copper mining, to which the BWCAW and Withdrawal Area are uniquely vulnerable

The Withdrawal Area abuts roughly 55 miles of the BWCAW boundary, occupies the upstream-most portion of the Rainy River-Headwaters watershed, and supplies the lakes and rivers downstream with exceptionally clean water. The almost entirely undeveloped and naturally vegetated nature of the watershed explains the "immaculate" quality[2] of nearly all of its waters, which flow north into the BWCAW and then westward down the Border Route chain of lakes shared with the Quetico Provincial Park (QPP), and on into Voyageurs National Park (VNP). Thus, the as-yet unprotected Withdrawal Area is an essential headwaters area on the U.S. side of the border not only to the BWCAW, but of greater Quetico-Superior region,[3] most of which is

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[2] MPCA (2017, June). *Rainy River-Headwaters Watershed Monitoring and Assessment Report*. Exec. Summary.
[3] Searle, R.N. (1977). *Saving Quetico-Superior: A Land Set Apart*. Minnesota Historical Society Press. ("The region known as Quetico-Superior is a matchless section of primeval North America. Encompassing the Boundary Waters Canoe Area of Superior National Forest, Voyageurs National Park, and Grand Portage National Monument in Minnesota, and Quetico Provincial Park in Ontario, the Quetico-Superior is the only region of its kind in the United

granted the highest protective designations available to public lands in the U.S. and Canada.

Absent protection, the Withdrawal Area could be converted in time into a sprawling sulfide-ore copper mining district. That would mean the destruction of the upper watershed's ability to produce and deliver ultra-clean waters downstream, causing irreparable harm to the incomparable BWCAW, VNP, and the Border Route lakes in the QPP.

I. The BWCAW, like the protected areas downstream, is unique, irreplaceable, and in large part defined by its pristine waters

a. The Boundary Waters Canoe Area Wilderness

The BWCAW is the nation's largest lakeland wilderness, and a national treasure of unmatched beauty and significance.[4] It extends 200 miles along the northeastern Minnesota border with Canada, and features a network of more than 1,175 lakes larger than 10 acres, 1,200 miles of rivers and streams, and uncounted wetlands – a vast amount of high-quality fresh water.[5] These waters are set in a landscape-scale mosaic of healthy northern forests, wetlands, hills, and cliffs.

The BWCAW is canoe country. Streams, rivers, and overland portages connect the lakes and convert the landscape into a vast network of potential routes.[6] The network of lakes and the energy efficiency of canoe travel make the BWCAW one of the most beautiful and accessible wilderness areas in the country. At 1.1 million acres, the BWCAW is the largest wilderness area east of the Rocky Mountains and north of the Everglades.

Due to vast water resources in the BWCAW, there also is a "dramatic interconnectedness" of forests with the lakes, streams, and wetlands. That interconnectedness, high degree of purity, and in particular the low buffering capacity of the region's waters and soils, "makes[s] the region unique and susceptible to degradation" from water pollution.[7]

States and Canada; its forest of boreal spruces and firs, mixed with northern hardwoods and pines, fringe thousands of cold, clear interconnected lakes and free-flowing streams. Quetico Provincial Park, the Boundary Waters Canoe Area, and Voyageurs National Park together comprise an international wilderness superbly designed by nature for canoeing.")

[4] Heinselman, M. (1996). *The Boundary Waters Wilderness Ecosystem*. University of Minnesota Press. Preface. ("More than 1,000 island-studded lakes, interconnected by hundreds of miles of streams and portages, are present within the Boundary Waters Canoe Area Wilderness. The wilderness contains the largest contiguous areas of virgin forest remaining in the eastern United States–half of its forested landscape has never been logged. The animal part of the ecosystem is also remarkably intact with most of the natural prey and predator species, making for remarkably complete food chains. Many of the mammals, birds, and fish that are present here are absent, rare, or endangered elsewhere in the contiguous 48 states.")

[5] Superior National Forest (n.d.a). *Water Resources of the Superior National Forest*. U.S. Forest Service, Dept. of Agriculture. Retrieved Jan. 8, 2022 from https://www.fs.usda.gov/detail/superior/about-forest/?cid=fsm91_049844. (SNF "contains nearly half of the Eastern Region's lakes, and 20% (total 440,000 acres) of the National Forest System fresh water…").

[6] Searle, R.N. (1977). ("Water is the dominant feature and provides the region's only natural highway.")

[7] U.S. Forest Service (2016, Dec. 14). Letter from Tidwell, T., Chief, to Kornze, N., Director, Bureau of Land Management. U.S. Dept. of Agriculture.

b. Quetico Provincial Park

QPP is a large (1,180,000-acre) wilderness park in northwestern Ontario, Canada, immediately north of and adjacent to the BWCAW, and offers excellent backcountry canoeing, camping, and fishing. The QPP is separated from the BWCAW only by the largely-unmarked US-Canada international border – a line that runs from point-to-point through the middle of the chain of lakes and portage trails known as the Border Route or Voyageur's Highway. QPP features more than 2,000 unimproved campsites scattered through more than 600 lakes. Visitors may reach Quetico through entry points in Canada, or by paddling through the Boundary Waters from the U.S. side, so long as the paddlers have an entry permit and a remote area border-crossing permit.

c. Voyageurs National Park

The Voyageurs National Park (VNP) was established to protect "the outstanding scenery, geological conditions, and waterway system which constituted a part of the historic route of the Voyageurs."[8] VNP is named for the famed French-Canadian canoe-men who were the principal European elements in the trade of furs and other natural resources with American Indians that connected the continental interior of North America with Atlantic ports and European consumers from the 1600s to 1800s. The routes they followed were the basis for the modern border between the U.S. and Canada. Many American Indian tribes have cultural connections to the VNP and larger region, including the Cree, Assiniboine and for nearly 400 years, the Ojibwe.[9] The United States and Canada are obliged under Article IV of the Boundary Waters Treaty of 1909 to ensure that each does not pollute waters that flow across the international border.

VNP covers 218,000 acres, including 134,000 acres of forest and 84,000 acres of lakes, and features more than 800 islands and 645 miles of shoreline. Water covers about 40% of the national park. It is one of only two national parks to protect a series of boreal lakes on the Canadian (Precambrian) Shield. The State of Minnesota has designated the waters of VNP "Outstanding Resource Value Waters," and considers it essential that the quality of these waters be maintained in order for them to continue to function as outstanding resources for many uses. Management of aquatic ecosystems is the first fundamental resource listed in the VNP Foundation Document (2016), and this work falls under Goal 1, Resource Protection, in VNPs Five Year Priorities 2018–2022. Additionally, during the development of the VNP Water Resources Management Plan, stakeholders chose park water quality as the number one issue, indicating that not only resource managers but also most affected parties are aware of the importance of the park's water resources. More than half of VNP maintains the qualities to qualify for wilderness designation and is managed by the NPS to protect those values.[10]

Visitors today – some 260,000 each year – come to fish, camp, bird watch, paddle, and tour on the National Park Service (NPS) tour boats, contributing $26 million to the local economies.[11]

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[8] Pub. L. 91-661, 84 Stat. 1970 (Jan. 8, 1971).
[9] National Park Service (2016, Aug.). Foundation Document: Voyageurs National Park, Minnesota. U.S. Dept. of Interior.
[10] *Id.*
[11] National Park Service (2021, May). *2020 National Park Visitor Spending Effects*: *Economic Contributions to Local Communities, States, and the Nation.* U.S. Dept. of Interior. Table A-1, p 38.

Many area residents and visitors also tour independently via private or rentable houseboats for day trips and overnight or weeks-long stays.

II. Sulfide-ore copper mining in the Withdrawal Area would cause "serious and irreplaceable harm" to waters of the Boundary Waters and Voyageurs National Park and their headwaters

a. Sulfide-ore copper mining is inherently polluting

Sulfide-ore copper mining invariably produces large amounts of waste rock and tailings. Overburden and other waste rock must be blasted, removed, and stockpiled to expose copper sulfide ore. The ore is then blasted and pulverized to the fineness of sand or dust and mixed with fresh water and processing chemicals to extract as much of the target metals as possible. Most of the rock that is mined as ore is destined to become tailings, a waste product. Tailings disposal facilities contain residual water, processing chemicals, and unrecovered heavy metals, all left in the environment. Heavy metals include nickel, copper, cobalt, arsenic, lead, mercury, zinc, cadmium, selenium, thallium, antimony, and others.[12,13] Tailings also contain acid dissociation products (hydrogen ions and sulfate). Even tailings that do not produce acid can produce leachate that impacts surface waters. According to a U.S. EPA review, tailings management plays a role in about half of all unpermitted releases of mining-impacted water.[14]

1. Sulfide-ore copper mining exposes high-sulfide and high-mineral rock to water and oxygen, setting up the conditions for acid mine drainage

Acid mine drainage (AMD) is the combination of acid and heavy metals leached from waste rock, tailings, mine walls, and other mine feature when sulfides formerly locked within bedrock are exposed to water and oxygen, forming sulfuric acid.[15] Once AMD begins, it can be impossible to control.[16]

AMD has multiple direct, indirect, and cumulative effects on receiving waters. Many forms of aquatic life are sensitive to pH ranges; if pH drops low enough it affects reproduction and mortality. Many heavy metals are also toxic to aquatic and other life at high concentrations. Low pH levels and/or high metals concentrations from AMD can extirpate species, guilds, or even all aquatic life from receiving waters. Because aquatic systems interact with riparian and terrestrial

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[12] *See* Paperny, A.M. (2014, Aug. 5). What's in Imperial Metals' Mount Polley tailings? Should you be worried? (Updated Sept. 9, 2014). *Global News.* [GlobalNews.ca, 8-5-2014, What's in Imperial Metals' Mount Polley tailings? Should you be worried?]
[13] *See* Duluth Metals (2014, Oct.). *Twin Metals Minnesota Project, Ely, Minnesota, USA, NI 43-101 Technical report on prefeasibility study*, Table 19-1, p. 19-3.
[14] U.S. EPA, Financial Responsibility Requirements Under CERCLA § 108(b) for Classes of Facilities in the Hardrock Mining Industry, 82 Fed. Reg. 3388 (Jan. 11, 2017).
[15] Chambers, D.M. (2014). *The Potential for Acid Mine Drainage and Other Water Quality Problems at Modern Copper Mines Using State-of-the-Art Prevention, Treatment, and Mitigation Methods*. Center for Science in Public Participation.
[16] U.S. EPA Office of Inspector General (2004, March 31). *Nationwide Identification of Hardrock Mining Sites.* (Report No. 2004-P-00005).

systems, heavy metal contamination from AMD can migrate into the sediments, soils, plants, and animals in connected terrestrial areas. The mobility of animals can result in the spread of heavy metals for substantial distances from the source or pathway of AMD pollution.

The U.S. Forest Service estimates that in the western U.S., where most federal lands are located, between 20,000 and 50,000 mines generate AMD and contaminate between 4,900 and 10,000 miles of rivers and streams.[17] More than 40 percent of the headwaters of rivers and streams in the American west have been polluted by mining.[18] Mines that produce AMD often require continuous on-site management and perpetual or "indefinite" water treatment.[19][20]

2. Sulfide-ore copper mining always pollutes water if there is water located at the site

The difficulty of mining without contaminating water is inherent in the fact that the very large areas of ground being disturbed are permeated with groundwater. If groundwater exists at the location of a mine, pollution *will* be discharged into the surrounding groundwater.[21,22] In the best of circumstances, it is difficult to predict where that groundwater will discharge to surface water. In northeastern Minnesota's geography, it will inevitably do so.[23]

The mining process described above results in enormous volumes of contaminated water. The logistics and difficulty of controlling that amount of water are unmatched by any other industry. While theoretically it might be possible, the evidence is that complete control has not yet been achieved at any mine, particularly not at a large mine located in an area where surface waters, wetlands, and high groundwater tables are ubiquitous.

Three sources of leachate from ore and waste rock impact ground and surface water at mines: host rock and backfill in the mine workings; rock, ore, and soil transported, used, stored, or disposed of on the surface; and waste tailings from ore processing. While every modern mine plan includes mitigation measures meant to limit how much of this leachate will enter the surrounding environment, mitigation measures often do not perform as well as assumed, for a host of reasons. Unidentified hydrological processes and events often provide unexpected

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[17] U.S. EPA Office of Inspector General (2004, March 31).
[18] U.S. EPA (2000, May). *Liquid Assets 2000: America's Water Resources at a Turning Point.* (EPA-840-B-00-001).
[19] U.S. EPA (2014, Jan.). *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*: *Vol. 1*
[20] Minn. Dept. of Natural Resources (MDNR), U.S. Army Corps of Engineers, U.S. Forest Service (2015). *Final Environmental Impact Statement NorthMet Mining Project and Land Exchange* (hereinafter "NorthMet FEIS") [Not included in Appendix], pp. 3-17, Table 3.2-2; 3-72 ("modeling performed in support of this FEIS indicates that water treatment systems would be needed indefinitely at the Mine Site and Plant Site"); 3-126 to -127; and 3-139.
[21] *See* NorthMet FEIS pp. 5-63 and A-680 (leachate from pits, stockpiles, and ponds would all enter groundwater).
[22] *See* Twin Metals Minnesota (2019a). *Scoping Environmental Assessment Worksheet Data Submittal,* lines 3964-3969 ("Groundwater that had contacted unmined surfaces and engineered tailings backfill would eventually migrate away from the mine in flow patterns similar to baseline conditions. As groundwater from the flooded mine mixes with adjacent groundwater, groundwater quality changes could occur.")
[23] *See* NorthMet FEIS A-680 ("The hydrologic and water quality modeling indicate that impacted groundwater would leave the NorthMet Project. At the Mine Site, this would include seepage of West Pit and East Pit water into groundwater during closure that would slowly migrate south to the Partridge River.")

pathways for discharges, and optimistic estimates of water volumes and quality often result in greater impact than expected from the leachate that does escape. These issues are discussed in greater detail in subsequent sections of these comments.

i. Water pollution from mine workings

Every large sulfide ore mine that intercepts water leaves behind a pit lake or underground area filled with contaminated water. These areas may not become problematic for the surrounding environment until many years after the mine has closed, when the pit or underground workings have filled with water. Contaminated water then begins moving into the surrounding groundwater.[24] As discussed in Part 2, Section A.II.e. below, hydrogeology is typically not sufficiently understood at these large sites to allow accurate predictions of the pathways that contaminated groundwater will take to surface waters.

There are no state-of-the-art mining practices that entirely prevent acidic conditions from developing in mine workings or groundwater from moving out of mine workings after flooding. Submerging sulfide-bearing rock in water (i.e. flooding the mine workings) can slow the acidification process, but does not result in uncontaminated water. Portions of the mine will remain open to moisture and air throughout the working life of any mine and after closure until the mine fills with water. Pillars, mine walls, and backfill provide acid-producing rock surface area.[25] In mines of the size and rock constituency as those being considered for the Rainy River-Headwaters, acidic conditions are likely to begin before mine closure, resulting in highly polluted water left in mine pits and underground workings after mining ends.

Modeling for PolyMet Mining's NorthMet Mine project[26] provides an estimate of the quality of water that will be left in the West Pit lake and as wetland porewater in the backfilled East Pit at that mine.[27] These predictions may underestimate some constituent levels, as has been true for every mine for which we have obtained relevant data. Nevertheless, they indicate that this water will be harmful to aquatic life. Deeper groundwater in the backfilled East Pit will be considerably worse; the values in the table below were chosen to illustrate the quality of water that will develop in wetlands at the East Pit site. The table provides the "most likely" estimate of water quality, assuming that inputs to the modeling are accurate. Units are ug/L; standards that vary based on hardness are given for a hardness of 100 mg/L.

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[24] *See, e.g.,* NorthMet FEIS 5-102 to -103.

[25] Zamzow, K. (2020, May 30). Memorandum to Matt Norton, Northeastern Minnesotans for Wilderness, re: Twin Metals Minnestoa, DEIS scoping period. Center for Science in Public Participation.

[26] PolyMet refers to the mining company, and NorthMet refers to the company's mine project, but since PolyMet Mining only has one mine project, NorthMet, in this comment, and in some of the sources quoted within, the terms may be used synonymously. NorthMet is the first mine project to be permitted in the Duluth Complex, and is located about

[27] PolyMet Mining Co. (2015, Feb. 27). *NorthMet Project Water Modeling Data Package – Vol. 1, Mine Site* (NorthMet FEIS ref. doc. PolyMet 2015m), Attachment G.

Pollutant	Class 2B Standard	East Pit Porewater	West Pit Lake Year 50
Arsenic	53	90	
Cadmium	2.5	5	
Cobalt	5.0	220	40
Copper	9.3	5,000	240
Nickel	52	2,000	500
Selenium	5.0	8	
Zinc	120	450	100
Sulfate	--	400,000 (400 mg/L)	50,000 (50 mg/L)

ii. Water pollution from stockpiles

A second source of potential impacts to water quality at sulfide-ore copper mines is rock and soil overburden stored or disposed of on the land surface. An example from Twin Metals Minnesota's proposed Maturi[28] mine plan is a ten-acre "Temporary Rock Storage Area" where sulfur-bearing rock would be stored during mine construction.[29] The area would subsequently hold an overflow ore stockpile that would be smaller but would consist of rock that is higher in sulfides and has already been crushed, likely resulting in poorer leachate quality. Neither pile would be covered. While every mine plan includes procedures and mechanisms to contain and collect leachate from stockpiles, releases to ground and surface water due to storm events, poor engineering, faulty liners, and human error are common.

The quality of leachate from such stockpiles is generally poor, and tends to deteriorate over time. A review of data from the Temporary Development Rock Storage Area at Eagle Mine in Michigan is illustrative.[30] As discussed below in Part 2, Section A.II.k.4., the quality of leachate is significantly worse than was predicted for permitting.

From 2013 to 2019, sulfate in leachate from the stockpile increased from 1000 mg/L to 2600 mg/L. Cobalt increased from less than 1 ug/L to 399 ug/L. Manganese increased from 400 ug/L to 2630 ug/L. Nickel increased from 10 ug/L to as high as 15,000 ug/L. These high concentrations are not outliers; they are in line with the steadily deteriorating water quality for each constituent and are representative of a number of other metals.

The quality of leachate from stockpiles was also modeled for the NorthMet mine.[31] Although the Maturi mine stockpiles would be smaller and of shorter duration, the NorthMet modeling is

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[28] Twin Metals Minnesota (Twin Metals) is a subsidiary to Antofagasta PLC, one of the largest copper mining companies in the world. Twin Metals claims interests in four mineral deposits. Twin Metals has so far submitted a proposal to mine a portion of just one of those deposits, the Maturi deposit. In these comments that proposed project is most commonly referred to as the "Maturi mine," or "Maturi project," though it may also be referred to it as the Twin Metals mine plan or project.
[29] Twin Metals Minnesota (2019a).
[30] Eagle Mine monitoring data used in these comments is from Eagle Mine annual reports (e.g., Kennecott Eagle Minerals (2012). 2011 *Annual mining and reclamation report*), available online at *Documents and Resources* (n.d.). Superior Watershed Monitoring Partnership Community Environmental Monitoring Program, https://swpcemp.org/resources/; and *Monitoring Results* (n.d.) Superior Watershed Monitoring Partnership Community Environmental Monitoring Program, retrieved Aug. 21, 2020 from https://swpcemp.org/monitoring/
[31] PolyMet Mining Co. (2015, Feb. 27), Attachment G.

relevant in regard to the potential quality of leachate. Furthermore, future mine plans in the Rainy River-Headwaters may include large stockpiles similar to those planned for NorthMet.

Again, these predictions may underestimate some constituent levels. The values in the table below are P90 predictions (ten percent probability that the water will be this bad or worse, if inputs to the modeling are accurate). Other than sulfate, units are ug/L; standards that vary based on hardness are given for a hardness of 100 mg/L. The Class 2B standards are relevant here because leachate is likely to discharge to nearby wetlands.[32]

Pollutant	**Class 2B standard**	**Category 2/3 stockpile**	**Ore surge pile**	**Category 1 stockpile**
Aluminum	125	800,000	820,000	
Antimony	31	2,400	2,600	90
Cadmium	2.5	200	200	8.0
Cobalt	5.0	24,000	40,000	320
Copper	9.3	165,000	165,000	660
Lead	3.2	550	550	100
Nickel	52	320,000	800,000	6,600
Selenium	5.0	130	160	70
Zinc	120	20,000	26,000	390
Sulfate	--	12,000 mg/L	13,000 mg/L	4,000 mg/L

Category 1 rock is classified as "low sulfur;" modeled constituent levels for that facility are based on a neutral pH. This illustrates that low sulfur materials can also leach metals and sulfate at problematic levels.

iii. Water pollution from tailings

In the Duluth Complex, more than 99% of the ore that is mined will be left as tailings.[33] While the disposal of tailings has always been problematic, it is becoming more so with the lower grade ores that are now being mined. An ore that grades at 0.33% copper, for example, will leave three times the volume of tailings for the same amount of copper recovered as an ore that grades at 1.0% copper.

Tailings are permanently disposed of as slurries behind an earthen dam, in piles on the land surface, in pits, or in underground workings. Methods of tailings disposal proposed for Duluth Complex mines thus far include tailings basins behind dams and dumping the tailings on cleared ground in a large mound (misleadingly referred to as "drystacking").

Regardless of the type of disposal facility, the enormous amount of ground rock left as waste from the mining process presents risks to surrounding waters. Even if tailings are truly non-acid generating, they can leach high levels of sulfate and metals. Modeling for the NorthMet project predicted a fifty percent probability of the following constituency of water leaching out of the

[32] NorthMet FEIS p. 5-319.
[33] *See* Duluth Metals (2014, Oct.), Table 1-4, p. 1-16.

tailings basin at that mine from one or more locations. Water quality standards that vary based on hardness are given for a hardness of 100 mg/L. Leachate is predicted to be pH neutral.[34]

Constituent	Surface water quality standard	Highest P50 concentration	Highest P50 concentration at Year 200
Sulfate	10 mg/L	800 mg/L	390 mg/L
Copper	9.3 ug/L	500 ug/L	380 ug/L
Lead	3.2 ug/L	100 ug/L	63 ug/L
Nickel	52 ug/L	750 ug/L	200 ug/L

The problems presented by nonacidic tailings are clear from Minnesota's taconite industry. Water seeping out of the Minntac tailings basin pollutes surface waters for many miles downstream.[35] Baseline water quality (as estimated from nearby unaffected waters) is about 3.2 mg/L sulfate and 100 uS/cm specific conductance. Seepage from the Minntac tailings basin has a sulfate level as high as 1320 mg/L and specific conductance as high as 3180 uS/cm. Ten miles downstream from the tailings basin on the Dark River, sulfate ranges from 125 to 489 mg/L and specific conductance ranges from 488 to 1412 uS/cm.

3. Mining operations include many other sources of water pollution

In addition to leachate from ore and waste rock, every mining operation includes many other features that can (and often do) release pollutants to water. These include ore processing facilities; ponds; pipelines and ditches; transportation facilities; explosives, fuel, lubricant, and reagent storage and handling; emergency generators; and more. Many such facilities include ancillary storage of hazardous materials. At the proposed Maturi mine, more than 3,000 deliveries would occur each year, or 75,000 deliveries over the planned life of the mine. Sulfuric acid, for example, would be delivered in 20-ton allotments, 42 times each year.[36] All mining operations experience spills, leaks, and/or other accidents, many of which result in the discharge of pollutants to surface waters and frequently, exceedances of water quality standards.[37] Ordinary day-to-day mining operations alone can result in ongoing water quality and ecosystem impacts.[38,39]

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[34] PolyMet Mining Co. (2015, March 13). *NorthMet Project Water Modeling Data Package – Vol. 2, Plant Site* (NorthMet FEIS ref. doc. PolyMet 2015j), Attachment F.
[35] MPCA (2016a). National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program Fact Sheet, Permit Reissuance MN0057207.
[36] Twin Metals Minnesota (2019a) Table 7-2.
[37] Gestring, B. (2012). *U.S. Copper Porphyry Mines: The track record of water quality impacts resulting from pipeline spills, tailings failures, and water collection and treatment failures*. Earthworks.
[38] *See* Wis. Dept. of Natural Resources (2012). *Surface water quality assessment of the Flambeau Mine site.* ("copper and zinc concentrations that frequently exceeded acute toxicity criteria" in local stream stemmed from "ore storage, ore crushing, and transport facilities as well as . . . wastewater treatment and administration buildings").
[39] *See* Ford, J., & Hasselbach, L. (2001). *Heavy metals in mosses and soils on six transects along the Red Dog Mine haul road Alaska.* National Park Service. (Impacts from transportation).

The U.S. EPA provides a description of the many processes that result in water contamination:

> EPA's research indicates that all processing of ore, including physical and magnetic processing, can result in spills of intermediate material and waste. This is because transport within the facility of the many different commodities and process chemicals used in hardrock mining activities is required between subsequent processing steps, thus resulting in risk of release. In addition, where operators use toxic process chemicals, the potential for harm associated with these spills is increased. Similarly, ore must be transported from the extraction site to the mineral processing facility. Process water and solutions are often stored in ponds on site for use and recycling. Slurries are piped from mill facilities to storage facilities (which can include waste management features such as tailings ponds) by pipeline, truck, or conveyor. The slurry, containing ore and process chemicals, can contain mobilized contaminants and other hazardous substances. EPA has documented that leaks also often occur due to liner failures, containment failures during transport or at exchange points (*e.g.*, conveyor drop points or truck offloads), and defects in pipe seams. EPA has also documented that operator error, such as mishandling of solutions (*e.g.*, over-fills) or equipment, and severe weather events that overwhelm containment systems can contribute to these types of releases.[40]

b. The Rainy Rivers Headwaters and BWCAW have high quality waters that are uniquely vulnerable to the impacts of sulfide mining

Waters in the Boundary Waters, the Mining Protection Area, and the Boundary Waters watershed upstream of the Wilderness boundary are of extremely high quality and have nearly no acid buffering capacity, low specific conductivity, and low concentrations of sulfates, nitrogen, phosphorus, and other pollutants. Low-to-no buffering capacity leaves the waters of the region highly sensitive to acid mine drainage.

1. Baseline water data from the 1950s to the present

Numerous sources of water quality data from federal and state agencies (backed by citizen water monitoring efforts) over a fifty-year period confirm that these waters have been of extremely high quality for as long as measurements have been taken.[41,42,43,44,45,46] According to data from the MPCA, northeast Minnesota has the lowest background specific conductance among the ecoregions of Minnesota, at 135 μS/cm. Data cited in Johnson & Johnson (2015) suggest that

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[40] U.S. EPA, 82 Fed. Reg. 3388.

[41] MPCA (2017, June). *Rainy River-Headwaters Watershed Monitoring and Assessment Report.* Available at https://www.pca.state.mn.us/sites/default/files/wq-ws3-09030001b.pdf

[42] MPCA (2011). *A Water Quality Assessment of Selected Lakes within the Kawishiwi River Watershed*.

[43] Myers, T. (2013). *Technical Memorandum: Twin Metals Mining and the Boundary Waters Canoe Area Wilderness, Risk Assessment for Underground Metals Mining*. Prepared for Northeastern Minnesotans for Wilderness, Ely, MN.

[44] Geerts, S.M. (2017). *2013 Project abstract for the period ending June 30, 2017*. Project Title: Assessment of natural copper-nickel bedrocks on water quality.

[45] Anderson, J., Thompson, D., Valley, R., & Butcher, J. (2010). *Sentinel Lake Assessment Report, White Iron Lake (69-0004), St. Louis County, Minnesota*. Minnesota Pollution Control Agency & Minnesota DNR.

[46] Freeman, A. and Freeman, D. (2016). YITW Water Quality Field Data Sheet [Excel Spreadsheet] (water quality data collected by Dave and Amy Freeman from September 2015 to September 2016).

background specific conductance in the BWCAW area is significantly lower than the ecoregion average, at 68 µS/cm.[47,48] Lake water quality data collected in the BWCAW by Dave and Amy Freeman in 2015 and 2016 also indicate that BWCAW waters have specific conductance levels far below the background level for the ecoregion as a whole.[49] MPCA water quality data collected over the last fifty years at the South Kawishiwi River Station (S000-108), a point that drains nearly all of the proposed Withdrawal Area, also shows extremely low specific conductance.[50]

Sulfate levels are also very low in most of the watershed, as shown in a table in the following section below. Unimpacted tributaries to Birch Lake and the South Kawishiwi River have sulfate levels that are consistently less than 1.0 mg/L.[51] An exception is the two rivers and bays that receive taconite mining discharge (Dunka River and Bay, and Unnamed Creek and Bob Bay), where levels are sometimes two orders of magnitude higher than background level.

2. Waters in the Withdrawal Area are unbuffered, circumneutral, and especially vulnerable to pollution

Waters of the Withdrawal Area as a whole are unique and susceptible to degradation from water pollution. The geological setting results in a lack of buffering capacity, which leaves the land and water of the Withdrawal Area vulnerable to acidic pollution.[52,53,54,55]

Waters in the BWCAW watershed are circumneutral. For example, USGS measurements of pH values at three locations along the Kawishiwi River, taken from 1958 to 1976, typically ranged from 6.5 to 7.3.[56] Average pH values in Keeley Creek (draining to Birch Lake) and Filson Creek (draining to the South Kawishiwi River) were lower at 6.1 and 6.2, respectively, likely because of the nature of the wetland areas they drained.[57] Values for pH at the South Kawishiwi River

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[47] Johnson, B.L., & Johnson, M.K. (2015). *An evaluation of a field-based aquatic life benchmark for specific conductance in northeast Minnesota.* Prepared for WaterLegacy.
[48] Cormier, S.M. (2016). *Scientific Review of B.L. Johnson and M.K. Johnson's, "An evaluation of a field-based aquatic benchmark for specific conductance in northeast Minnesota" (November 2015)*. U.S. EPA.
[49] Freeman, A. and Freeman, D. (2016).
[50] MPCA (n.d.a). Surface Water Data Viewer data S. Kawishiwi River - Station S000-108. [Excel Spreadsheet]. Retrieved Jan. 6, 2022 from https://webapp.pca.state.mn.us/surface-water/station/S000-108.
[51] Pugh, L. (2021). *2020-2021 Sulfate Sampling Effort for Birch Lake (69-0003-00).* Northeastern Minnesotans for Wilderness.
[52] Siegel, D.I., & Ericson, S.W. (1980). *Hydrology and water quality of the Copper-Nickel Study region, northeastern Minnesota.* [Water-Resources Investigations 80-739]. U.S. Geological Survey, Dept. of Interior.
[53] Baker, L.A. (2013). *Potential ecological impacts of the Twin Metals Mine.* Prepared for Northeastern Minnesotans for Wilderness.
[54] Chambers, D.M. (2014).
[55] Myers, T. (2016a). Acid Mine Drainage Risks - A Modeling Approach to Siting Mine Facilities in Northern Minnesota USA. *Journal of Hydrology, 533,* 277–90. http://dx.doi.org/10.1016/j.jhydrol.2015.12.020
[56] USGS data from field/lab water quality samples collected at stations 05125000, 05126210, and 05127000 may be accessed online via the USGS National Water Information System at: https://nwis.waterdata.usgs.gov/usa/nwis/qwdata/?site_no=05125000; https://nwis.waterdata.usgs.gov/usa/nwis/qwdata/?site_no=05126210; and https://nwis.waterdata.usgs.gov/usa/nwis/qwdata/?site_no=05127000.
[57] Geerts, S.M. (2017).

monitoring station (S000-108) similarly tend to range from mid-6 to high 7.[58] Such sensitive variation indicates that changes in acid content in surrounding waters, such as from acid mine drainage, would have a demonstrable effect on the area's clean water resources.[59]

3. BWCAW waters have the highest level of protection

As some of the most highly valued, pristine waters in the state and country, Minnesota has afforded the waters of the BWCAW the highest protection available under federal and state law. BWCAW waters have been designated as "Prohibited Outstanding Resource Value Waters," (ORVW)[60] which aligns with the "Outstanding National Resource Waters" designation of the federal Clean Water Act.[61,62] As such, MPCA may not grant permits for "a proposed activity that results in a net increase in loading or other causes of degradation" to BWCAW waters.

The ORVW designation reflects the policy that *no* lowering of water quality is acceptable for *any* reason. In short, mining cannot be permitted if any pollutants from mining facilities or activities would reach BWCAW waters. As all waters in the Rainy River-Headwaters flow into the BWCAW, siting a mine here is inherently problematic.

The prohibition of any lowering of water quality in a small subset of the state's and nation's waters reflects a goal to preserve the best of what we have left in the most untouched state possible. As America's premier wilderness area dedicated to nonmotorized water travel, with one of the least developed landscapes and some of the least polluted water in the country, the BWCAW is a fitting area for this high level of protection. A primary point here is that it was the low level of human development throughout its watershed that made the BWCAW a candidate for this level of protection in the first place. We cannot allow sulfide-ore copper mining development in the Rainy River-Headwaters and expect the BWCAW to maintain its existing water quality.[63]

4. The Rainy River-Headwaters Watershed is of high priority for protection

The Minnesota Pollution Control Agency released its Draft Rainy River-Headwaters Watershed Restoration and Protection Strategy Report in August 2021 (hereinafter, "WRAPS Report").[64] The report focuses on pollutants that generally increase from any land clearing and development,

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[58] MPCA (n.d.a). Surface Water Data Viewer data S. Kawishiwi River - Station S000-108. [Excel Spreadsheet]. Retrieved Jan. 6, 2022 from https://webapp.pca.state.mn.us/surface-water/station/S000-108.
[59] Baker, L.A. (2013).
[60] Minn. R. 7050.0265 subp. 7 and .0335 subp. 3.A. This designation is rare in Minnesota, applying only to the BWCAW, Voyageurs National Park, the portion of Lake Superior off the shore of the Grand Portage Reservation, segments of two rivers designated as "Wild" under the National Wild and Scenic Rivers Act, and thirteen small Scientific Natural Areas. The BWCAW is the largest designated Prohibited ONRW.
[61] 40 C.F.R. § 131.12.
[62] Brawer, J.M. (1999). Antidegradation policy and Outstanding National Resource Waters in the Northern Rocky Mountain States. *Pub. Land & Resources L. Rev. 20,* 13.
[63] This point is thoroughly illustrated by MPCA's 2021 Draft Rainy River – Headwaters Watershed Restoration and Protection Strategy Report.
[64] MPCA (2021, Aug). *Draft Rainy River-Headwaters Watershed Restoration and Protection Strategy Report*. Available at https://www.pca.state.mn.us/sites/default/files/wq-ws4-87a.pdf.

including sediment (total suspended solids), phosphorous, and nitrogen. Mining necessarily involves significant land clearing and development, and the report is useful for assessment of that aspect of potential mining in the watershed. A more detailed discussion is found in Part 2, Section A.II.g. below.

According to the report, the general lack of development in the watershed is the primary reason for its very high quality water, and protection from degradation due to development (of all kinds) is a top priority.

Other reports from the same MPCA effort focused on biological indicators in specific streams.[65,66] These reports indicate that several high-quality streams are located in the proposed Withdrawal Area, including Denley, Keeley, and August Creeks and the Dunka and Stony Rivers. These are some of Minnesota's very highest quality streams, and are at high risk of impacts from mining. The MPCA watershed monitoring report concludes, "Overall, lakes and streams within the Rainy River-Headwaters Watershed have benefited from little developmental pressure. However, these systems are highly sensitive to anthropogenic stressors like most waterbodies in northern Minnesota. A continued vigilance is necessary to monitor areas where developmental pressures are or will be expected to occur. [67]

5. The ubiquity of water in the Boundary Waters watershed heightens the risk of contamination and makes containment and recovery of released contaminants highly improbable

Fresh water is everywhere in the Boundary Waters watershed, including the Kawishiwi River area. The Kawishiwi River is an important canoe travel route that flows through the heart of the Boundary Waters Canoe Area Wilderness. Much of the watershed is covered by a surficial aquifer consisting of glacial till or sand and gravel generally less than 3-6 meters thick.[68]

"The dramatic hydrogeology and interconnectedness of the BWCAW's forests, lakes, streams, and wetlands make the region unique and susceptible to degradation."[69,70] Constant interaction of surface waters and groundwater that is very close to the surface increases the likelihood of the spread of pollutants throughout the system.[71] In a very wet environment such as the Boundary Waters watershed, existing technologies are unlikely to be capable of capturing contaminants once they are released.[72] This is particularly true if large volumes of contaminants are involved, if the failure is not immediately detected when it occurs, or if the release occurs over, under, or

[65] MPCA (2017, June).
[66] MPCA (2019, July). *Rainy River Headwaters Stressor Identification Report.* These reports and supporting documents are available at https://www.pca.state.mn.us/water/watersheds/rainy-river-headwaters.
[67] MPCA (2017, June).
[68] Myers, T. (2016a).
[69] U.S. Forest Service (2016, Dec. 14).
[70] Myers, T. (2013).
[71] Kuipers, J.R., Maest, A.S., MacHardy, K.A., & Lawson, G. (2006). *Comparison of predicted and actual water quality at hard rock mines: The reliability of predictions in Environmental Impact Statements.*
[72] Levit, S. (2018b) *Follow-up report: Acid mine drainage and other water quality problems at modern copper mines using state-of-the-art prevention, treatment, and mitigation methods*. Center for Science in Public Participation.

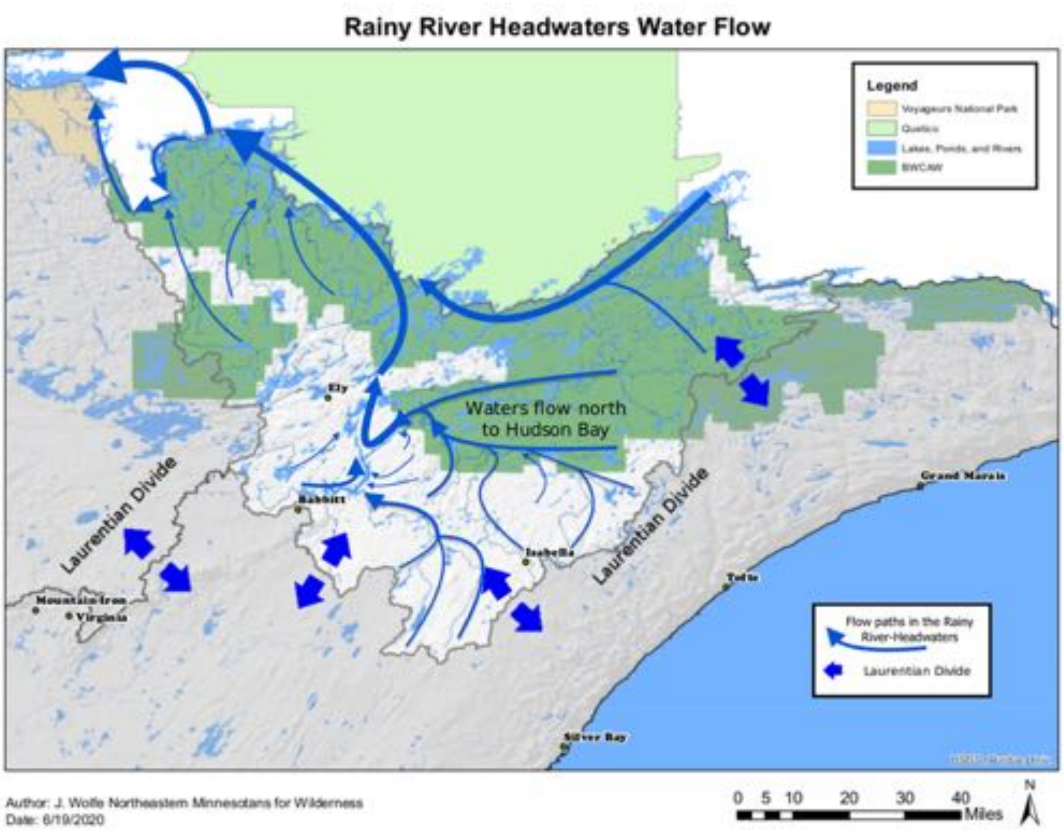
adjacent to water. As is true of most of the watershed, the Twin Metals' proposed site is riddled with wetlands, streams, and lakes that flow into the South Kawishiwi River.[73]

c. Pollutant discharges from sulfide-ore copper mines in the Rainy River-Headwaters would reach the BWCAW

Sulfide-ore deposits in the Rainy River-Headwaters are upstream of the BWCAW and linked to it by a continuous water connection. As discussed throughout these comments, sulfide-ore copper mines always release pollutants to nearby surface waters. These pollutants will travel downstream to the BWCAW. State agencies recognize that development in headwaters results in lower quality water and aquatic habitat downstream.[74] Whether from spills or seepage of water from mine facilities or from increased runoff and sediment from deforestation, BWCAW waters *would* be affected by mining operations in their headwaters.

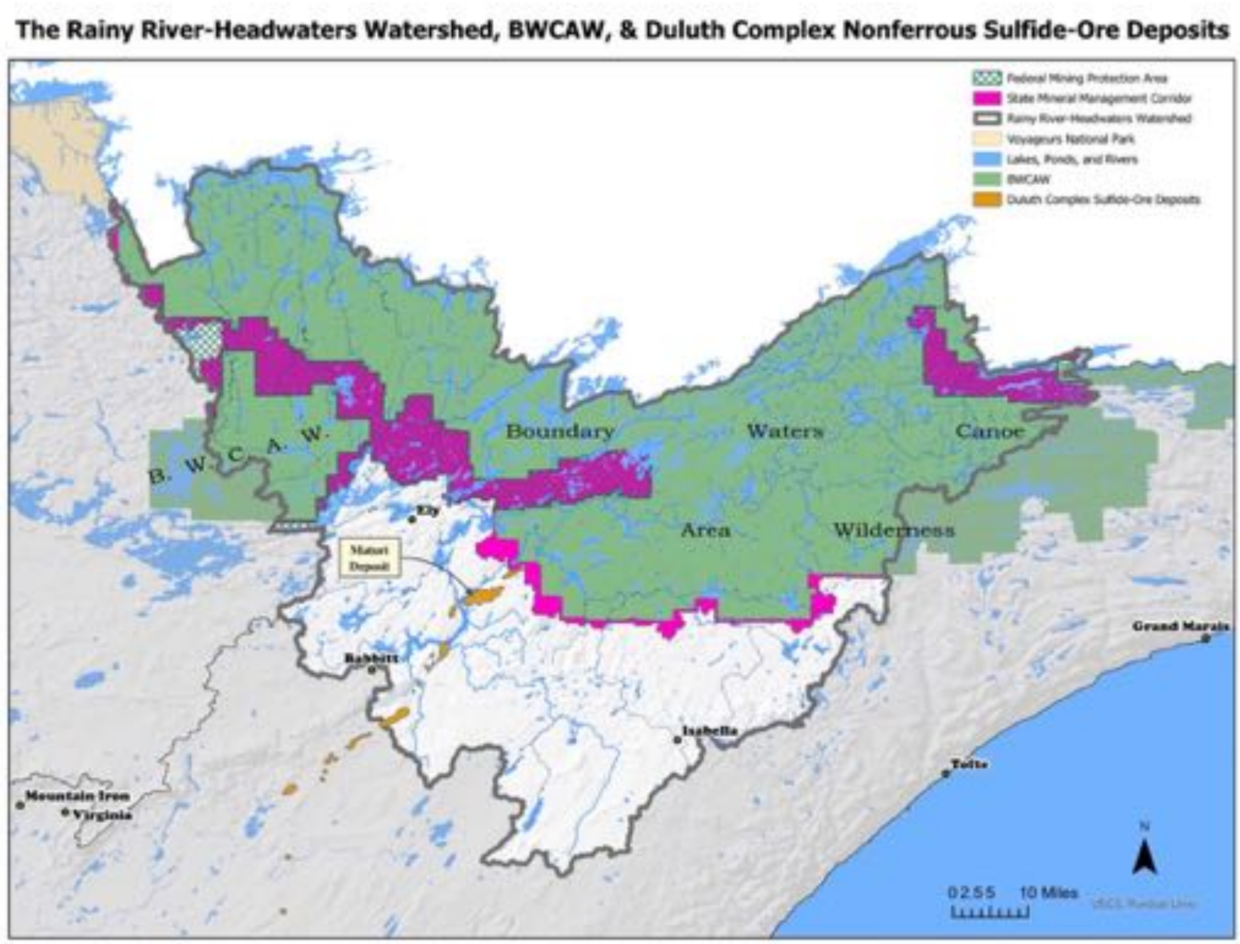
1. In the Rainy River-Headwaters, surface waters flow from the southern part of the watershed, which is unprotected from mining, into the BWCAW

Surface water in the Rainy River-Headwaters flows from the southern portion of the watershed to the north and west, into and through the BWCAW, as shown below.



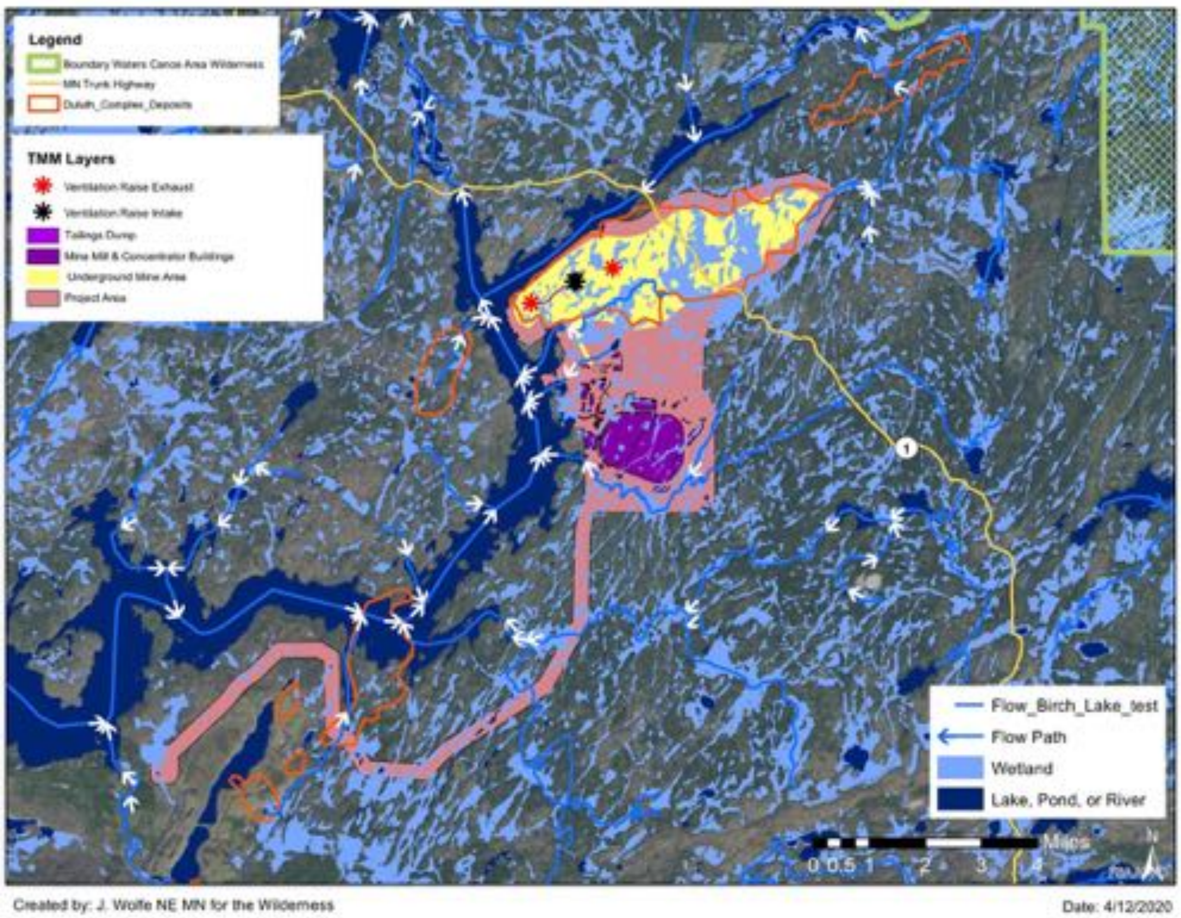
[73] Myers, T. (2013).
[74] MPCA (2017, June).

The sulfide-ore copper deposits (and hence potential mine locations) are south and upstream of the BWCAW:



Water is everywhere in the Rainy River-Headwaters, underfoot or nearby. As with the other sulfide-ore deposits in the watershed, the proposed Maturi project site is surrounded and crisscrossed by wetlands, streams, rivers, and lakes that flow to the BWCAW.

Surficial Hydrology & Antofagasta PLC's Proposed Maturi Sulfide-Ore Copper Mine



2. Hydrological modeling indicates that sulfide-ore copper mining pollution would reach surface waters flowing into the BWCAW

Peer-reviewed groundwater flow and contaminant transport modeling published in the Journal of Hydrology in 2016 assessed the movement of sulfate pollution from above-ground and below-ground sources at potential sulfide-ore copper mines in the Rainy River-Headwaters. The modeling indicated that "groundwater with substantial contaminant concentrations discharges to streams whether sourced from deep underground or the ground surface," and that even relatively short-term surface leaks could cause significant pollutant loads to reach rivers and downstream waters.[75]

[75] Myers, T. (2016a).

Three scenarios of pollution releases were modeled, representing normal operating conditions at a mine as described in the Twin Metals pre-feasibility report,[76] and tracked the movement of pollution from mines and mine facilities into the BWCAW. The paper shows that under ordinary operations, mine contaminants would move with groundwater flows, intercept surface waters, and flow into waters of the BWCAW.[77,78]

Flows from underground sources would have variable but potentially high concentrations. The level of pollutant concentrations discharging to surface waters would depend in part on the length of the flowpath. Groundwater travelling through some flowpaths could take a long time to discharge to surface water, such that contamination may not become obvious until after a mine closes. Pollution levels could remain elevated for hundreds of years. Modeling showed peak loads from underground sources reaching rivers in 10 to 40 years. Releases in the Birch Lake area would discharge to surface waters relatively quickly.

In the modeling, peak loads from surface sources reached rivers and streams in less than five years. Shorter flowpaths reached streams within two years, with higher concentrations due to less attenuation. A stream near one of the modeled sources had the highest loading, with a sulfate concentration of 120 mg/L. Model results were conservative, in that had longer-term leaks been modeled, peak concentrations reaching rivers would likely have been higher. Pollutants would discharge to surface waters at detectable levels and would flow to the BWCAW downstream. During critical low flow periods, these discharges would cause potentially significant damage to rivers and to BWCAW waters.[79]

3. Mines and other pollutant sources in headwaters regions increase pollutant loading and concentrations in waters many miles downstream

Studies document the capacity for mine drainage in river headwaters to increase metals and sulfate in water and sediments tens of kilometers downstream, even with dilution from uncontaminated tributary streams. For example, elevated copper and zinc concentrations were documented some 20 kilometers downstream from mine discharge in the Blackfoot River headwaters, in the sediments of wetlands through which the river flowed. [80] Cadmium concentrations in benthic fauna and fish livers were elevated up to 25 km downstream from the source of mine drainage. Despite dilution effects, pollutants moving through freshwater wetlands accumulated in the food web, with zinc, copper, and nickel contamination being particularly problematic.

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[76] Duluth Metals (2014, Oct.).
[77] Myers, T. (2016a).
[78] Modeling is based on reasonable assumptions and the best available data. First, the modeled mine facilities are based on the Twin Metals Pre-Feasibility Study Technical Report (Duluth Metals, 2014, Oct.). Second, modeled releases are based on typical releases at operating mines; as explained elsewhere in these comments, no sulfide-ore copper mine has operated and closed without polluting surrounding surface or groundwater.
[79] Myers, T. (2016a).
[80] Moore, J.N., Luoma, S.N., & Peters, D. (1991). Downstream effects of mine effluent on an intermontane riparian system. *Canadian Journal of Fisheries and Aquatic Sciences, 48,* 222–32.

In another study, simulations of the downstream effects of nitrogen additions and losses in headwaters streams indicated that "pollutant sources and hydrological and biogeochemical processes in headwaters are physically and biochemically connected to the water quality conditions in downstream waters of widely varying sizes, including navigable waters and their tributaries."[81] It was found that first-order headwaters streams can contribute 40% to 55% of the nitrogen in fourth- and higher-order streams. The study concluded that "major changes in [pollutant] loads in a subset of 25% of the headwater catchments would be expected to change [the pollutant] loads by about 10-12% in the waters downstream of these headwaters."

Headwaters land use changes that increase the use or release of a particular pollutant correlate with increased concentrations and loading of that pollutant in lower parts of the watershed.[82] Land-use changes that increase the flow or flashiness of downstream waters, such as stream channelization or straightening projects that decrease channel length or remove natural wetlands, pools, and riffles, are more likely to increase loading downstream. Such changes reduce the opportunities for nutrient detention in the hyporheic zone, and shorten travel time. Presumably, similar consequences could be expected of other activities with similar effects on headwaters hydrology. Wetland ditching, diking and flow diversion of surface waters and runoff to fewer and shorter flow paths, increased impervious surfaces, compacting or stripping soil, and deforestation are examples of land use change effects that are common at mine sites and increase the flashiness of streams draining the affected area. Some or all of these factors would be present at the proposed Maturi mine site, and would likely occur at any mine site in the watershed.

In northeastern Minnesota the effects of mining can be seen in elevated specific conductance in the St. Louis River, from a point where it first receives discharge from mined lands to a point some 57 river miles downstream.[83] The upper portion of the St. Louis River is unaffected by mining discharge, with specific conductance levels typical for the region (mean of 59 $\mu S/cm^2$). At the point where the river first receives drainage from significant mining activity, specific conductance increases to 258 $\mu S/cm^2$. Over the following 57 miles, as the river receives input from other streams draining both mined and unmined areas, mean specific conductance remains at 260 $\mu S/cm^2$.

The Partridge River, a St. Louis River tributary, is impaired by mine pit dewatering discharge from the Lake Superior basin side of the Peter Mitchell Pit, a taconite mine that crosses the Laurentian Divide. The pit delivers significant sulfate loading to the uppermost headwaters of the Partridge River.[84] For more than 34 miles downstream, from the mine pit to its confluence with the St. Louis River, the Partridge River is impaired for sulfate.[85] At MPCA stream monitoring

[81] Alexander, R. B., Boyer, E. W., Smith, R. A., Schwarz, G. E., & Moore, R. B. (2007). The role of headwater streams in downstream water quality. *Journal of the American Water Resources Association*, *43*, 41–59. https://doi.org/10.1111/j.1752-1688.2007.00005.x
[82] *Id.*
[83] Johnson, B.L., & Johnson, M.K. (2015).
[84] Dewatering discharge from MN0046981-SD-009 over 13 years of monthly measurements had just three sulfate readings less than 10 mg/L. The average low sulfate concentration over those thirteen years was 16.9 mg/L, and the average high was 38.7 mg/L. MPCA (n.d.b). Monitoring data for Northshore Mining Co. Peter Mitchell, MN0046981-SD-009. Retrieved Nov. 22, 2021, from https://webapp.pca.state.mn.us/surface-water/station/MN0046981-SD-009
[85] MPCA (n.d.c). Impaired Waters Data Viewer. https://www.pca.state.mn.us/water/impaired-waters-viewer-iwav

station S004-595, more than 25 miles downstream from the discharge, the sulfate concentration is 21.3 mg/L, far above the normal background levels of streams that do not drain mine lands.[86]

MDNR has acknowledged that nonferrous-ore mining in headwater areas will increase loadings to waters for a significant distance downstream. The NorthMet FEIS states that "the NorthMet Project Proposed Action, in combination with other reasonably foreseeable actions, would increase metal and other solute loadings to the Partridge River, Embarrass River, and further downstream in the St. Louis River."[87] The St. Louis River is approximately 30 miles downstream of both the mine site on the Partridge River and the tailings basin on the Embarrass River.

4. Existing mine features in the Rainy River-Headwaters generate detectable increases in pollutants more than five miles downstream

Existing mine facilities have also increased pollution loads and concentrations far downstream in the Rainy River-Headwaters system. Both the Peter Mitchell Pit and Dunka Pit mining area discharge sulfate to Birch Lake that remains apparent for the entire length of Birch Lake.

i. <u>The Peter Mitchell Pit and Dunka Pit mining area discharge high levels of sulfate to Birch Lake tributaries</u>

The Peter Mitchell Pit, a taconite mine owned by Northshore Mining/Cleveland-Cliffs, discharges pit water to the Dunka River, which flows to Birch Lake, through four discharge points. Based on data available from MPCA's online Surface Water Data Viewer, SD-001 appears to have been inactive since October 2010; monitoring data from 2007 to 2010 indicate sulfate levels ranging from 32.5 to 111 mg/L. From 2017 to 2021, sulfate levels in discharge at SD-002 ranged from 42 to 184 mg/L,[88] at SD-004 from 59 to 181,[89] and at SD-005, from 42 to 258 mg/L.[90]

The nearby closed and flooded Dunka Pit and its associated stockpiles discharge to Birch Lake through Unnamed Creek and through a stream referred to by regulators as Flamingo Creek. Both Unnamed Creek and Flamingo Creek discharge to Bob Bay.[91] Stockpile leachate flows through passive treatment ponds before discharging at SD-006 (Flamingo Creek) and SD-004, -005, -

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[86] MPCA (n.d.d). Partridge R. monitoring data for S004-595. [Excel spreadsheet]. Retrieved Nov. 22, 2021 from https://webapp.pca.state.mn.us/surface-water/station/S004-595

[87] NorthMet FEIS p. 6-32.

[88] MPCA's Surface Water Data Access webpage and data viewer portal lacks the standard option of downloading a spreadsheet of monitoring data for this discharger. Data for SD-002 is available at MPCA (n.d.e). Impaired Waters Data Viewer data MN0046981-SD-002. Accessed Jan. 4, 2022 via: https://webapp.pca.state.mn.us/surface-water/station/MN0046981-SD-002

[89] MPCA (n.d.f). Impaired Waters Data Viewer data MN0046981-SD-004. Accessed Jan. 4, 2022 via: https://webapp.pca.state.mn.us/surface-water/station/MN0046981-SD-004

[90] MPCA (n.d.g). Impaired Waters Data Viewer data MN0046981-SD-005. Accessed Jan. 4, 2022 via: https://webapp.pca.state.mn.us/surface-water/station/MN0046981-SD-005

[91] Barr Engineering (2016, July). *Draft Summary of the Long-Term Mitigation Evaluation and Implementation Plan for the Dunka Mining Area. NPDES-SDS Permit No. MN0042579*. Prepared for Cliffs Erie LLC.

007, -008, and -009 (Unnamed Creek). Pit water is discharged into the Dunka River without treatment via SD-001.[92]

From January 2010 through April 2019, the five permitted discharge points that cover leachate from stockpiles discharging to Unnamed and Flamingo Creeks had average sulfate levels of 649 to 1658 mg/L.[93,94] The NPDES/SDS discharge permit (MN0042579) does not require monitoring and reporting of sulfate data in discharge from the pit (SD-001), and MPCA's Surface Water Data Access tool provides no sulfate data for this discharge point.[95] However, data obtained through a Data Practices Act request indicates average sulfate levels ranging from 74 to 97 mg/L between 2015 and 2017.[96,97]

ii. Sulfate concentrations are very low in the streams of unmined watersheds discharging to Birch Lake

Northeastern Minnesotans for Wilderness (NMW) has undertaken a water quality monitoring program on Birch Lake and its tributaries using MPCA protocols and chain-of-custody documentation. Data from that program show that sulfate levels in tributary creeks that have not been impacted by mining are extremely low, as opposed to mining-impacted tributaries where sulfate levels are very high:[98]

92 *Id.*, p. 24
93 MPCA (n.d.h). Cliffs Erie LLC-Dunka. [Excel spreadsheet].
94 MPCA (n.d.i). Dunka DMR Data 2010-2019. [Excel spreadsheet].
95 *See* MPCA (n.d.j). Impaired Waters Data Viewer data MN0042579-SD-001 accessed Jan. 4, 2022 https://webapp.pca.state.mn.us/surface-water/station/MN0042579-SD-001
96 MPCA (2017, May). 2017-05-31_Dunka MPCA Additional Monitoring. [Excel spreadsheet].
97 MPCA (2015, Aug.). Dunka January 2014 – May 2015 Average sample results. [Excel spreadsheet]. (Draft Dunka data vs proposed permit limits 7-10-15)
98 Northeastern Minnesotans for Wilderness (2021, June). 2020-2021 Birch Lake sulfate data submitted to EPA. Additional data that have not yet been tabulated are available on request.

Water name	Agency Station ID, if applicable	NMW Station ID, if applicable	Sample Date	Result, SO4 (mg/L)
Stony River	S002-811		2020, Aug. 18	0.9
Nira Creek	5620		2020, Aug. 18	0.6
Keeley Cr.	5039		2020, Aug. 12	< 0.5
Keeley Cr.	5039 (f.d.)		2020, Aug. 12	< 0.5
Keeley Cr.	5039		2021, June 15	< 0.5
Keeley Cr.	5039 (f.d.)		2021, June 15	< 0.5
Keeley Cr.		KEL-001	2020, Aug. 18	< 0.5
Keeley Cr.		KEL-001 (f.d.)	2020, Aug. 18	< 0.5
Keeley Cr.		KEL-002	2020, Aug. 18	0.2
Keeley Cr.	5035		2020, Aug. 13	< 0.5
Keeley Cr.	5037		2020, Aug. 12	< 0.5
Keeley Cr., trib.		KEL-TRIB	2020, Aug. 18	0.3
Keeley Cr., trib.		KEL-TRIB	2021, June 16	0.5
N. Nokomis Cr.		NNOK-001	2020, Aug. 12	< 0.5
South Kawishiwi R.	S002-812		2020, Aug. 13	1
Unnamed Cr., to Filson Cr.	4988		2020, Aug. 18	0.2
Filson Cr.	4990		2020, Aug. 13	< 0.5
Birch R.	S007-765		2021, June 24	0.6
Birch R.	S007-765		2021, Sept. 28	1.9
Unnamed Cr. to Bob Bay, B.L.	5730		2020, Aug. 13	237
Unnamed Cr. to Bob Bay, B.L.	5730		2021, June 16	344
Unnamed Cr. to Bob Bay, B.L.	5730 (f.d.)		2021, June 16	339
Unnamed Cr. to Bob Bay, B.L.	5730		2021, July 19	394
Unnamed Cr. to Bob Bay, B.L.	5730 (f.d.)		2021, July 19	370
Unnamed Cr. to Bob Bay, B.L.	5730		2021, Sept. 8	379
Unnamed Cr. to Bob Bay, B.L.	5730 (f.d.)		2021, Sept. 8	440
Unnamed Cr. to Bob Bay, B.L.	5730		2021, Sept. 26	632
Unnamed Cr. to Bob Bay, B.L.	5730 (f.d.)		2021, Sept. 26	636
Dunka R.	S007-766		2021, June 24	11.0
Dunka R.	S007-766		2021, Sept. 28	93.4

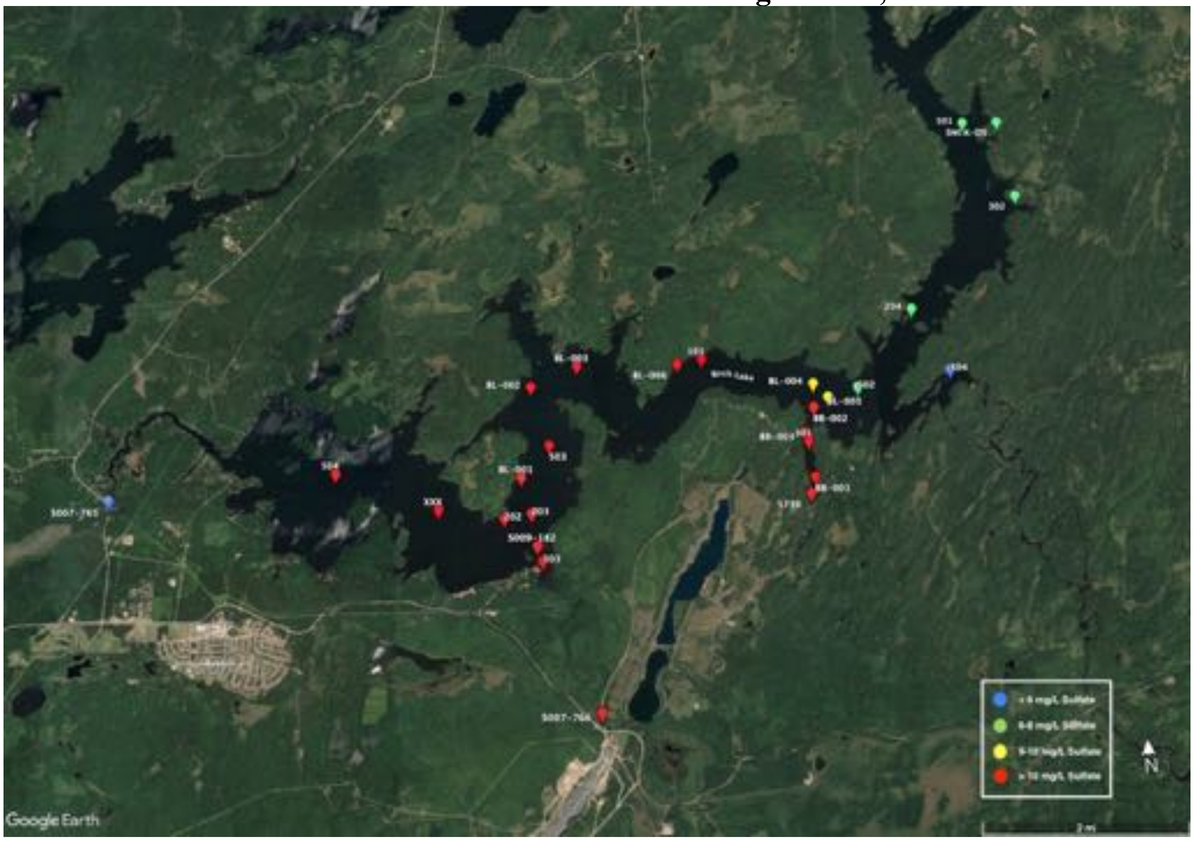
No NMW samples showed tributaries in unmined watersheds with sulfate concentrations greater than 2 mg/L, and most results were well below 1 mg/L. No NMW samples from tributaries draining watersheds with active or closed mines showed sulfate concentrations below 10 mg/L. Twin Metals sampling results in 2017 and 2018 confirm low sulfate levels in streams whose watersheds do not host mines, with a 0.8 mg/L average for Stony River, 0.2 mg/L average for N. Nokomis Creek, 0.1 mg/L average for S. Nokomis Creek, and 0.3 mg/L average for Keeley Creek.[99]

iii. Mapping of monitoring data indicates that mining-related discharges raise sulfate concentrations miles downstream

While monitoring data in Birch Lake show significant sulfate loading form existing taconite mines, proposed sulfide-ore copper mining in the Rainy River-Headwaters would create new sources of more highly contaminated waste and water, increasing the loading and concentration of sulfate and other pollutants downstream. The sum area of all watersheds draining to Birch Lake exceeds 360 square miles, excluding the watershed of the South Kawishiwi River.[100] Although drainage from the Peter Mitchell Pit and Dunka Mine Area cover approximately 5% of that area (about 21 square miles)[101] and the remaining 95% of the watershed is drained by streams with extremely low sulfate levels, the Peter Mitchell Pit and Dunka Mine discharges elevate the sulfate concentration in the entirety of Birch Lake far above background levels, for many miles downstream from the points of discharge.[102] Mine land discharges raise sulfate concentrations above 10 mg/L for a roughly 7-mile-stretch of Birch Lake, as shown in the figure below.[103]

[99] Twin Metals Minnesota (2019a), Table 6-9.
[100] MPCA (2017), Appendix 3.2.
[101] This is a rough estimate made using Google Earth.
[102] Pugh, L. (2021).
[103] *Id*. Figure 7.

2020-2021 Birch Lake Sulfate Monitoring Results, Binned



In the northeastern portion of Birch Lake where sulfate concentrations fall below 10 mg/L, sulfate levels nonetheless remain at least an order of magnitude higher than background levels found in tributaries that do not have mining features in their watersheds.[104,105] Elevated sulfate levels persist downstream, and represent significant degradation of water quality.

d. Duluth Complex rock is acid-producing

1. The Duluth Complex contains rock that generates acid, heavy metals, and sulfate

The fact that the Duluth Complex hosts rock that is acid generating is beyond question. This has been established by long-term, voluminous studies by MDNR,[106,107,108] by ongoing monitoring of

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[104] *Id*.
[105] Brezonik, P.L. (2021, Sept. 20). Letter to Maccabee, P., WaterLegacy, and Norton, M., Northeastern Minnesotans for Wilderness.
[106] Kellogg, C., Lapakko, K., Olson, M., Jenzen, E., & Antonson, D. (2014). *Laboratory dissolution of blast hole samples of Duluth Complex rock from the South Kawishiwi Intrusion: Twenty-four year laboratory experiment*. MDNR. https://files.dnr.state.mn.us/documents/lam/reclamation/file/ed914dcf-3d03-4b20-8d0b-b237f3cf3760/mndnr_blast_hole_expt_2014.pdf
[107] Lapakko, K.A., & Antonson, D.A. (2012). *Duluth Complex rock dissolution and mitigation techniques research summary.* MDNR.
[108] Lapakko, K.A., Engstrom, J.N., & Antonson, D.A. (2004). *Long term dissolution testing of mine waste.* [Report to US Army Corps of Engineers Contract/Order No. DACW45-02-P-0205]

drainage from Duluth Complex stockpiles at the Dunka Pit[109,110] and by lab testing of target ore and waste rock from the NorthMet[111] deposit. The Dunka Pit is a closed taconite mine that excavated and stockpiled Duluth Complex overburden; it is located within the Rainy River-Headwaters watershed, one mile from the Twin Metals Birch Lake deposit and within 10 miles of the proposed Maturi mine. The AMAX bulk sample site (the source of rock for many MDNR studies) is located near Babbitt, about 10 miles from the Maturi site. The NorthMet mine site is in the Lake Superior basin, close to the Rainy River divide and approximately 15 miles from the proposed Maturi site.

All of the referenced sources indicate that rock from the Duluth Complex will produce acidic leachate with very high levels of heavy metals and sulfate. The mineral deposits that Twin Metals hopes to develop in the Rainy River-Headwaters watershed (Maturi, Maturi Southwest, Birch Lake, and Spruce Road) have higher concentrations of sulfides than either the NorthMet deposit or Dunka mine waste rock. Accordingly, there is reason to expect that pollution from mining in the Birch Lake area will be worse than what has or will occur at other Duluth Complex deposits.[112]

Once acid mine drainage (AMD) occurs, it can be impossible to control.[113] To quote a 2008 literature review for the U.S. Fish & Wildlife Service:

> Acid mine drainage commonly forms as a result of natural geochemical processes that oxidize metal sulfides exposed at the earth's surface by mining. Oxidation of sulfur and hydrolysis of iron result in acid-sulfate waters which have been observed at thousands of historic mine sites and at operational mines where mitigation measures have failed to prevent the release of acid mine drainage to down-gradient surface waters. . . . . Problematic to the long-term operation of large scale metal mines is recognition that no hard rock surface mines exist today that can demonstrate that AMD can be stopped once it occurs on a large scale. Evidence from literature and field observations suggests that permitting large scale surface mining in sulfide-hosted rock with the expectation that no degradation of surface water will result due to acid generation imparts a substantial and unquantifiable risk to water quality and fisheries.[114]

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[109] U.S. EPA (1994, Dec.). *Technical Document: Acid Mine Drainage Prediction* (EPA530-R-94-036)
[110] Interstate Technology & Regulatory Council (2010, August). *Case Study - Dunka Mine, Minnesota*. Mining Waste Treatment Technology Selection Web. Washington D.C.
[111] PolyMet Mining Co. (2015, Feb. 13). *NorthMet Project Waste Characterization Data Package Version 12.* (NorthMet FEIS ref. doc. PolyMet 2015q).
[112] Chambers, D.M. (2018a). *The Potential for Acid Mine Drainage in the Duluth Complex Magmatic PGE Deposits*.
[113] U.S. EPA Office of Inspector General. (2004, March 31).
[114] Jennings, S.R., Neuman, D.R. & Blicker, P.S. (2008). *Acid mine drainage and effects on fish health and ecology-A review*. Reclamation Research Group. Prepared for U.S. Fish and Wildlife Service, Anchorage Fish and Wildlife Field Office.

2. Acid generation is likely to begin before mines are closed and backfilled

Although the potential for excavated rock from the Duluth Complex to generate acid is beyond dispute, mining companies continue to assert that acid drainage will never become a problem at their mines. Twin Metals, for example, argues that Duluth Complex rock has sufficient neutralizing capacity to delay the onset of acid production until a mine is closed and potentially acid generating rock is buried under water (eliminating the oxygen needed for acidification).[115] This delay is commonly referred to as "lag time."

MDNR has taken issue with Twin Metals' position: "Relying on a so-called lag time to acid generation to implement controls to avoid development of AMD requires additional investigations and analysis beyond what has been conducted to date," and "The assertion that higher [should state "lower"] total sulfur content rocks being capable of maintaining a circumneutral leachate only occurs for a very specific sulfur content and bulk mineralogy."[116]

Misguided reliance on lag time to assume that a mining operation will not generate acid is a common reason why sulfide ore copper mining operations pollute water. The Kuipers/Maest 2006 Comparison Report (discussed extensively below) describes several mining EISs that acknowledged that acid generation could occur but overpredicted the lag time, resulting in significant pollution. These mines include Greens Creek in Alaska; Thompson Creek in Idaho; and Beal Mountain and Golden Sunlight in Montana.[117]

Some of the ways mining companies manipulate lab test data to arrive at water quality predictions are discussed in Part 2, Section A.II.k.4. below; one of those methods is the application of "scaling factors" to lab test data based on the assumption that water quality in the field will be significantly better than in lab tests. Predictions based on scaling factors consistently under predict impacts. The application of scaling factors to the lag times indicated by lab testing provides significant potential for error. For example, a test sample for the NorthMet project that had a lag time of 5.41 years in the laboratory was calculated to have a lag time of 23.6 years in the field.[118] When preventing acid generation is dependent on submerging rock in water before the rock turns acidic, the uncertainty of this timing is extremely problematic.

The bottom line is that excavating potentially acid-generating rock *always* presents risks to local and downstream waters. Self-serving mining company predictions about lag times or other factors that will allegedly result in an operation without acid drainage issues should not be allowed to obscure this fundamental fact.

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[115] Twin Metals Minnesota (2019b). *Mine Plan of Operations*, lines 3505 to 3508.
[116] MDNR (n.d.a). *Twin Metals Minnesota EIS scoping—RGU comments on proposer's initial data submittal*, comments 370 to 373.
[117] Kuipers, J.R., Maest, A.S., MacHardy, K.A., & Lawson, G. (2006). *Comparison of predicted and actual water quality at hard rock mines.*
[118] NorthMet FEIS A-560.

e. Accurate understanding of hydrogeology of a mine site in the Rainy River-Headwaters may not be possible as a practical matter, presenting high risk of unexpected surface water contamination

The amount of water at a potential mine site and its speed and direction of flow both above and below ground are key elements in any assessment of the potential for the mine to impact ground and surface water. If characterization of groundwater flow, overland flow, precipitation, wetland characteristics, or stream flows are inaccurate, predictions of impacts will also be inaccurate. Inadequate understanding of the hydrogeology of a site is a primary reason why mines so often have unanticipated water quality impacts.[119]

Hydrogeology in northeastern Minnesota is particularly complex, heterogeneous, and difficult to assess. MDNR takes the position that detailed assessment of the hydrogeology of sites this large and heterogeneous is not possible, and allows mining projects to proceed with a very low level of understanding of the hydrogeology of the site. In these circumstances, it is inevitable that hydrogeological conditions will be other than assumed, and contaminated groundwater will discharge to surface waters in unexpected ways.

1. Accurate understanding of the hydrogeology of a site is critical to predicting and preventing impacts to water quality and wetland and stream hydrology

At any mine site, water that has contacted ore or waste rock, tailings, mine workings, disturbed soils, or spilled materials will drain into the ground or seep into surrounding rock or soil. This water will carry pollutants with it as it enters and travels through groundwater. If the hydrogeology of a site is poorly characterized, the areal extent to which those pollutants will travel, the amount that will discharge to surface water, and the locations where that discharge will occur will be unknown at the time of permitting.

There are two primary issues regarding mischaracterization of hydrogeology. The first involves inaccurate characterization of the site as a whole. An assessment of average groundwater flow conditions ("bulk hydraulic conductivity" and a general understanding of groundwater flow direction) is usually undertaken. Bulk hydraulic conductivity assessment provides an estimate of the average rate of groundwater flow through bedrock and through unconsolidated deposits across an entire site. These average rates of flow are combined with average distances to a downgradient stream, lake, or wetland to estimate the degree to which highly polluted groundwater will attenuate before discharging to surface water. [120]

Problems arise when the bulk hydraulic conductivity assessment is based on too few data points and/or inadequate testing methods. The data set may be too small to provide an accurate picture even of typical conditions at the site. In addition, "preferential pathways" – groundwater

[119] Kuipers, et al. (2006).
[120] Attenuation occurs by several mechanisms, including dispersion (the spread of polluted groundwater over a larger area as it moves and dilution by the unimpacted groundwater it encounters), and sorption of certain pollutants to constituents of the rock that the groundwater passes through. Misapplication of attenuation factors can also result in failure to predict water quality impacts. These and other errors in impact assessment are often cumulative.

pathways that allow groundwater to move through the ground more quickly than average and/or in an unexpected direction – are not intercepted or investigated. One result will be an inaccurate estimate of average conditions, because areas of faster groundwater movement in higher volumes are not factored into the average. This will in turn result in errors in predicting the amount of inflow of groundwater into the mine (and thus the amount of dewatering that will be needed), impacts from groundwater drawdown on area wetlands and streams, the areal extent of groundwater pollution, and the overall amount of pollution that will ultimately discharge to surface water.

The second primary issue has to do with the specific locations of and localized impacts from the preferential pathways that are not identified. These impacts may include unanticipated, anomalous high levels of pollution in wells, wetlands, small lakes, tributary streams, and river reaches above assessment points. Because mine sites in the Rainy River-Headwaters would each cover several square miles, a bulk assessment that does not identify locations of fracturing, faulting, and other anomalies allows for the pollution of significant water resources. Failure to identify preferential pathways can also negate the potential for effective installation of mitigation measures, adequate monitoring programs, and effective remedial activity.

Following closure of a mine, dewatering ends and the workings refill with water. At that point polluted water starts to travel away from the mine through groundwater, potentially discharging to re-emerging wetlands and surface streams. This may not occur until decades after the mine has closed, when the mining company no longer exists. If hydrogeology of the site is poorly characterized, this polluted water may move more quickly or in a different direction and volume than expected, and may be of poorer quality when it discharges to surface water.

2. Duluth Complex bedrock is faulted and fractured, making preferential groundwater pathways likely

Bulk hydraulic conductivity is based on average conditions at a site, but water does not move through ground in a uniform way. To a greater or lesser extent depending on geology, preferential pathways allow polluted groundwater to move at a greater speed and with less attenuation in some locations than is average for the site.

Preferential pathways through bedrock are particularly likely in areas where bedrock is fractured and/or faulted. The broad consensus among geologists is that the upper few hundred feet of bedrock in northeastern Minnesota, including the Duluth Complex and other formations that surround it, is significantly fractured and faulted. In comments on behalf of WaterLegacy regarding the NorthMet Project EIS, J.D. Lehr, a geologist with particular expertise in northeastern Minnesota geology, wrote:

> The rocks of the Duluth Complex are indeed fractured and faulted. Faults are documented in several recently published geologic maps of the NorthMet property and surrounding areas (Severson and Miller, 1999; Miller and Severson, 2006a, 2006b, 2006c, 2006d; Jirsa *et al*, 2005; Jirsa *et al*, 2011; Jirsa *et al*, 2012) (Figure 1; Figure 2). This is also common knowledge amongst geologists working in the area. Even PolyMet's own geologists describe the rocks at the Mine Site as being fractured and faulted – they

> specifically mention 14 separate faults zones that transect the Mine Site (PolyMet, 2007b) (Figure 2). Some of the SDEIS' supporting literature also correctly characterizes the bedrock at the Mine Site as fractured in certain places. The presence of fractures in this part of the Duluth Complex has been known since the Copper-Nickel Study days. Siegel and Ericson (1980) reported that *"fractures and joints in the Duluth Complex may extend to considerable depths but are more extensive in the upper 200 to 300 feet of the bedrock"* (p. 7).[121,122]

In explaining that a highly detailed hydrogeological investigation will be necessary in this area for the siting of solid waste facilities,[123] MPCA explained,

> [In] much of northeastern . . . Minnesota . . . fractured basement rocks are the only aquifers available and locally important. Fractures and cracks may be interconnected, but only in a few known sites do they contain enough storage space to have significant water yields over large areas. As with ground water flow, any potential pollutant migration is through the fractures. The fractures are difficult to locate, and they lead to complicated, unpredictable flow patterns. Thus, it can be very difficult to develop a reliable ground water monitoring system. If basement rocks are shallow enough to be of interest at a land disposal site, the hydrogeologic investigation must identify any fractures, determine how they are interconnected, delineate how ground water moves through them, and figure out how to monitor them.[124,125]

In his criticism of the hydrogeological study done for the NorthMet Mine, Chief Geologist of the Minnesota Geological Survey Anthony Runkel stated:

> Faults of potential hydraulic significance are common in the Duluth Complex, including near the Mine Site ((Minnesota Geological Survey (MGS) S-21 and/or MGS M-119)), and the tectonic history, as well as glacial and erosional history of the region, includes activity capable of generating extensive fracture systems that post-date emplacement of the complex. Second, the manner in which data were collected at the Mine Site, especially the use of long open hole intervals for hydraulic testing and water sampling, is insufficient to test the hypothesis that extensive high transmissivity fractures or fractured zones are absent. Discrete fractures and fractured zones commonly go unrecognized when hydrogeologic measures such as water chemistry, hydraulic conductivity, and heads are averaged across several tens to hundreds (most boreholes at the site) of feet of

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[121] Lehr, J.D. (2014). Technical Memorandum: Summary of Comments Resulting from Review of NorthMet Mining Project and Land Exchange Supplemental Draft EIS. Prepared for WaterLegacy. (Emphasis in original.)
[122] Siegel, D.I., & Ericson, S.W. (1980). *Hydrology and water quality of the Copper-Nickel Study region, northeastern Minnesota.* [Water-Resources Investigations 80-739]. U.S. Geological Survey, Dept. of Interior.
[123] MDNR and MPCA treat mining waste as exempt from Minnesota's solid waste disposal rules.
[124] MPCA (1988). *In the matter of proposed rules governing solid waste management facility permits, and the design, construction, and operation of solid waste management facilities, Statement of need and reasonableness*, p. 324. The extensive hydrogeological investigation required for siting municipal solid waste disposal facilities is explained on pages 338 to 356.
[125] *Citing* Bruemmer, L.B., & Clark, T.P. (1986). *Ground Water in Minnesota: A User's Guide to Understanding Minnesota's Ground Water Resource.* MPCA and Minn. State Planning Agency.

> bedrock. Scale effect is also a factor. Boreholes are less likely to intercept hydraulically active fractures than the proposed pit walls.
>
> . . . . Information from outside of the Mine Site area appears to be inconsistent with the SDEIS suggestion that densely fractured uppermost bedrock has been removed by glacial scouring in the area. A site-specific example is a well-known contamination site in a younger Midcontinent Rift intrusive complex near Finland Minnesota where abundant fractures in the uppermost 100 feet of bedrock serve as fast-flow groundwater conduits (e.g. Harza Engineering Company, 1999). Furthermore, specific capacity data from Duluth Complex water wells ((County Well Index (CWI)) in northeastern Minnesota also are suggestive of enhanced fracturing in uppermost bedrock. Specific capacity tests of 366 wells in the Duluth Complex indicate hydraulic conductivities for wells open only to the upper 100 feet of bedrock are about two orders of magnitude greater than for wells open to greater depths beneath the bedrock surface. The shallower wells have average and median hydraulic conductivity values calculated from specific capacity data that are 3-4 orders of magnitude greater than the bulk conductivity value used in the modelling of the Duluth Complex at the Mine Site as described in the SDEIS.[126]

In a review of available data from the South Kawishiwi River area, hydrogeologists Peter Kang and Joe Magner express concern about agency reliance on bulk hydraulic conductivity to assess impact at a site with fractured bedrock:

> In fractured aquifers, fracture specific transmissivity is a relevant measure and not bulk hydraulic conductivity. Many scientific studies show significant flow can occur in deep mining sites (> km) including nearby Soudan mine site (Lin et al., 2006; Holland et al., 2013). Even if average hydraulic conductivity is low, fracture transmissivity can be locally very high and induce significant mine inflow and outflow.[127]

The likelihood of faulting and fracturing at the Maturi site, which would contribute to preferential groundwater flows through the bedrock and therefore result in significantly more (and more rapid) pollution migration, also seems to be understood by the mining industry technical experts who reviewed and contributed to Twin Metal's Prefeasibility Study Reports (sometimes referred as National Instrument 43-101, or "NI 43-101" reports, the term used in Canadian mining regulations) released in 2014.[128,129]

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[126] Runkel, A.C. (2014). *Comment on the NorthMet Supplemental Draft Environmental Impact Statement*. Minnesota Geological Survey, University of Minnesota.
[127] Magner, J., & Kang, P. (2021). Considerations for hydrologic/hydrogeologic pathway and process analysis of proposed sulfate mining in Minnesota. [Technical memo].
[128] Duluth Metals (2014, Oct.), pp. 24-11 to -12.
[129] Duluth Metals Limited (2014, April). *Maturi, Maturi Southwest, Birch Lake, and Spruce Road Cu-Ni-PGE Projects: NI 43-101 Technical Report,* p. 9-3.

3. Adequate hydrogeological testing for Duluth Complex sites is unlikely to be required for permitting, and may not even be possible

The level of hydrogeological study required for mine permitting in Minnesota does not identify preferential groundwater pathways. Investigations of faulting and fracturing of bedrock and of high-conductivity zones in the unconsolidated deposits (which is also known to occur in the Duluth Complex area and could provide preferential pathways for polluted groundwater) are not required.

In response to the many objections to the lack of a detailed hydrogeological study for the NorthMet Mine, MDNR, the U.S. Army Corps of Engineers, and the U.S. Forest Service responded:

> Methods have been developed evaluating chemical transport through discrete fracture systems in hard rock. However, it is acknowledged within the industry that these theoretically based methods are simply not practical and reliable for large field sites. Discrete fracture transport models require intensive characterization of fracture apertures, orientations, and pervasiveness that can never be accomplished for a large field area. These models have only been applied successfully to small rock masses at pilot test sites, but never to a large-scale field problem. For field-scale evaluations, the standard of the industry is to treat fractured rock as an equivalent porous medium and use surrogate parameters (e.g., low effective porosity) to model chemical transport within the large rock mass. This is the approach taken in the [NorthMet] FEIS and *it is the only practical method that can be employed for impact evaluation*.[130]

The agencies also stated, "it is unlikely that any reasonable field program would be able to identify the existence, location, and hydraulic characteristics of faults that may or may not be present at the site."[131]

For the NorthMet project (the only sulfide-ore copper mining project to be permitted thus far in Minnesota), not only was the study limited to characterization of bulk hydraulic conductivity, but that characterization itself is highly uncertain because of the limited amount of data that informed it. At the mine site, modeling of groundwater movement through Duluth Complex rock used data from just five field tests.[132] A theory behind bulk assessment is that fracture transmissivity will be factored in to the average when fractures have been intercepted in drilling. However, the smaller the data set, the less likely fractures will be intercepted, and even where a

[130] NorthMet FEIS A-679 (emphasis added).
[131] NorthMet FEIS A-79.
[132] PolyMet Mining Co. (2015, Feb. 27). *NorthMet Project Water Modeling Data Package Version 14.* (NorthMet FEIS ref. doc. PolyMet 2015m) p. 30.

fracture is intercepted, flow at that one point is unlikely to reflect fracture transmissivity of the entire site.[133,134]

An equivalent paucity of data was collected to assess bulk hydraulic conductivity of the surficial deposits, which is known to be highly variable in the Rainy Lobe (which overlays the Duluth Complex at both the NorthMet and Maturi sites).[135] Rainy Lobe till contains linear belts of sand and gravel that mark the former positions of the Rainy Lobe ice margin where it retreated through northeastern Minnesota and northwestern Ontario. Lab tests of surficial sediments taken from locations in the vicinity have shown hydraulic conductivity values ranging from less than a foot to several hundred feet per day.[136] Siegel and Erickson (1980) report hydraulic conductivity measurements of surficial sand and gravel in the Minnesota Copper-Nickel Study area of from 10-3,500 feet per day, and of Rainy Lobe till ranging from 0.01 to 30 feet per day. To understand what this means in regard to the range of potential groundwater flow, the study estimated the sustained inflow to a 400-acre open pit mine in the Birch Lake vicinity as ranging from 100 to 2,000 gpm.

At the NorthMet mine site, the range of horizontal hydraulic conductivity from just 10 tests of glacial drift was 0.012 ft/day to 31 ft/day.[137] Conducting only ten tests over an approximately eight square mile area with this degree of heterogeneity obviously leaves an enormous amount of uncertainty. No effort was made to determine whether preferential flowpaths (e.g., buried sand and gravel deposits) exist and might affect either bulk conductivity or discrete groundwater flows to and from area wetlands or streams. Even without the existence of such flowpaths, the range, mean and median values at the site could all be wildly different than represented by this few data points.

4. The "only practical method that can be employed for impact evaluation" is likely to result in unpredicted water quality impacts at Duluth Complex mine sites

Many factors play into the judgment of adequacy of hydrogeological studies in a particular location, including the extent of faulting, fracturing, and other anomalies known to occur in the area, the distance to potentially impacted surface waters, and the quality and value of those waters. In the Rainy River-Headwaters, faults are known to exist, upper bedrock is known to be fractured, surface waters are ubiquitous, and the quality and value of those waters are among the highest of any in the nation or indeed, the world. What regulatory agencies deem "the only practical method that can be employed" to assess hydrogeology at large mine sites is insufficient to protect water resources in the Rainy River-Headwaters.

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[133] *Id. ("*hydraulic conductivity estimates from borehole tests are scale-dependent (i.e., due to heterogenity of the fracture network, fracture flow to the borehole may be greater or less than fracture flow of the aquifer at a larger scale)).

[134] Runkel, A.C. (2015, Dec. 21). *Comment on the NorthMet Final Environmental Impact Study*. Minnesota Geological Survey, University of Minnesota.

[135] Siegel, D.I., & Ericson, S.W. (1980).

[136] Lehr, J.D. (2014).

[137] PolyMet Mining Co. (2015, Feb. 27)

In regard to the NorthMet mine, Chief Geologist Runkel points out:

> The FEIS justifies the exclusion of [available assessment] techniques mostly by suggesting that the current level hydrogeologic characterization for the NorthMet site is adequate, and that it is based on techniques and assumptions that are "standard approaches" or "common practice" in the mining industry.
>
> . . . . .
>
> If the approach used to characterize the hydrogeologic conditions at the NorthMet site is indeed consistent with standard practice, it might be beneficial to reconsider the standard, or if that standard is appropriate for a project of this magnitude. A standard that might be sufficient for basic water budget (quantity) predictions may not be a sufficient standard for an activity such as sulfide-ore copper mining, where transport of contaminants (water quality) is of equal importance to water quantity. The latter should require a more comprehensive hydrogeologic understanding of a site.[138]

In earlier comments on the project, Runkel pointed out that the methods used for the NorthMet assessment led to results that were inconsistent with known conditions at sites with similar geology:

> Investigations aimed at characterizing the hydrogeologic conditions of fractured bedrock for the purposes of predicting solute transport in crystalline bedrock elsewhere on the Canadian Shield routinely use a number of well-known techniques that were not applied in the hydrogeologic studies at the NorthMet Mine Site and Plant Site/Tailings Basin area. A key component of those investigations is the acquisition of hydraulic and water chemistry data at relatively discrete intervals of bedrock, with the focus on fracture characterization. . . . . When these techniques have been used in generally similar hydrogeologic settings elsewhere on the Canadian Shield, the results support hydrogeologic conceptual models that differ substantially from those proposed for the Duluth Complex and Giants Range Batholith described in the SDEIS. Of particular significance for solute transport, the conceptual models commonly include key fractures or fracture zones of relatively high hydraulic conductivity, and multiple flow systems within the bedrock at individual sites. These flow systems are variably connected to the surface water system, have variable residence times, can have upward and downward vertical gradients within a local area, and horizontal flow directions that differ from one another.
>
> The data collected thus far from the proposed NorthMet Mine Site and Plant Site/Tailings Basin area are not sufficient to recognize the kinds of hydrogeologic features known to be characteristic of other crystalline bedrock settings on the Canadian Shield, described above. Nor are the data sufficient to adequately support the simpler conceptual model currently depicted in the SDEIS. . . . .[139]

[138] Runkel, A.C. (2015, Dec. 21).
[139] Runkel, A.C. (2014.)

Minnesota agencies themselves would not accept such a limited hydrogeological study for activities that could pollute groundwater in any context other than mining. MPCA's solid waste rules[140] do not allow the siting of waste disposal facilities in areas with fractured bedrock unless the fractures are identified and adequately understood, explaining:

> [The rules] require[] that a facility be located only in an area where ground water flow paths and variations in soil or bedrock conditions are known in sufficient detail to enable reliable tracking of pollutant movement. This condition prevents siting in areas where the geology is so complex or unpredictable that a hydrogeologic investigation cannot adequately define groundwater flowpaths. At such a site, there is little chance for success in tracking leachate movement if it escapes the engineered containment system. . . . [S]ome of Minnesota's soil and bedrock conditions fit this description. . . . A[n] example is fractured bedrock. The fractures often can be difficult to define and provide rapid and unpredictable pathways for pollutant movement. [The rules] allow[] the Agency to reject a site where ground water and pollutant movement cannot be adequately defined.[141]

An indicator that bedrock faults and fractures in the Maturi area may be interconnected and result in significant movement of contaminants is provided by an affidavit from the owner of a sizeable resort on the northeast shore of Birch Lake, located roughly equidistant between the Maturi and Maturi SW deposits. The wells at this resort have provided drinking water over decades of use. The water quality in wells that intercept bedrock fractures deteriorated rapidly between 2006 and 2014 – the time period during which exploratory drilling was occurring across the lake. One well saw a 40-fold increase in metal content, to the point that silverware and plumbing fixtures began to tarnish and corrode, and guests complained about the water's taste and color. The resort's location in comparison to the areas that were drilled during those years suggests bedrock fracture flows over distances of at least several thousand feet.[142]

To the extent that impacts such as these are localized (i.e., not consistent over the entire mine site), it is highly unlikely that they could be predicted from the level of data and analysis that was accepted for the NorthMet project.

Magner & Kang (2021) point out (and provide data showing) the existence

> of a high degree of variability in groundwater chemistry along the east bank of the [South Kawishiwi River] that is not linked to a depth or location suggesting a high degree of heterogeneity. The connectivity of fractures in the bedrock is unknown, but the well testing data infer clearly different water chemistries. This information is presented to illustrate a real-world example of complex hydrogeology in northeastern Minnesota.[143]

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[140] Minn. Admin. Rules Chapter 7035. The requirements discussed in these comments are found in rule 7035.2815, which explicitly applies to municipal solid waste facilities but is generally used in permitting non-mining industrial facilities as well. MPCA (2009, June). *Industrial Landfill Guidance.* https://www.pca.state.mn.us/sites/default/files/w-sw5-20.pdf

[141] MPCA (1988).

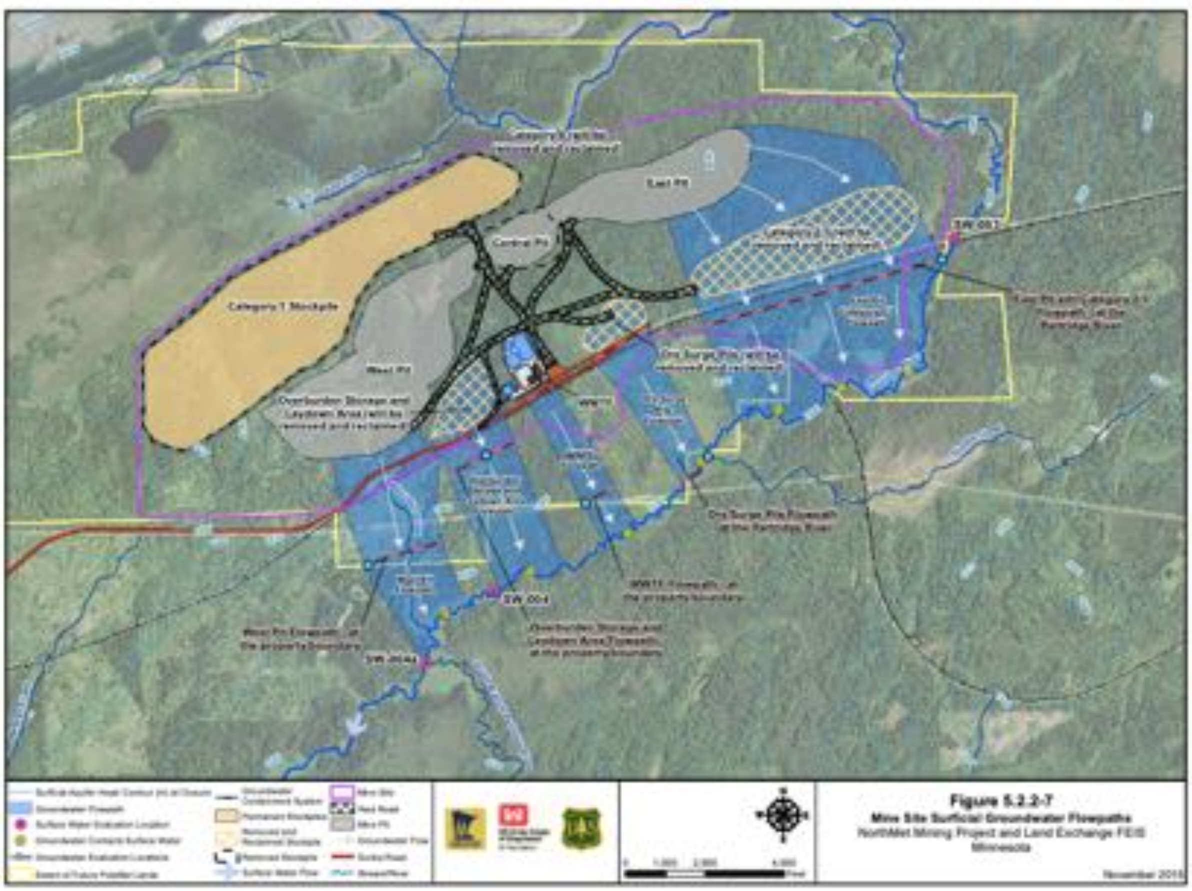
[142] Koschak, S.L. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].

[143] Magner, J., & Kang, P. (2021). Considerations for hydrologic/hydrogeologic pathway and process analysis of proposed sulfate mining in Minnesota. [Technical memo].

The implications of this heterogeneity, which was measured at the edge of the South Kawishiwi River at the proposed Maturi mine site, would not be revealed in a bulk hydraulic conductivity assessment.

A lack of investigation and data can result in erroneous assumptions about the distance that groundwater will travel before discharging to surface water and the location where the discharge will occur. To the extent that modeling assumes attenuation of pollutant concentrations through dispersion and adsorption, the length of a groundwater flowpath is critical to an accurate assessment of water quality at the point of discharge. An accurate assessment of the location of discharge is also important, as the volume of surface water at the point of discharge is used to calculate water quality after the discharge mixes with surface water. If pollutants are modeled as travelling through the ground for longer distances and/or discharging to surface water at a point with greater dilution capacity than would actually be the case, the model will predict better water quality than will actually occur.

The modeling done for the NorthMet mine is illustrative. The FEIS figure showing the flowpaths used in modeling is reproduced below.



This figure is not an accurate representation of the actual flow of groundwater at the site, but is instead a representation of flowpaths used in modeling, which are not the same. Groundwater at the site actually flows in all directions outward from the area designated as the East Pit and

Category 1 stockpile, including to the north and east.[144] Flow in those directions was assumed to be low to the point of insignificance, but there are insufficient data to support that assumption.

It is clear from this figure that groundwater flowing north from the East Pit[145] after mining ends will arrive at the Partridge River by a much shorter flowpath than water flowing south. The flowpath to the river from the East Pit at the shortest point to the north appears to be less than 1500 feet; the modeled distance from the East Pit to the Partridge River was 6955 feet.[146] The north side of the pit will also allow the greatest flow through bedrock, because the upper portion of the bedrock on the north side of the pit is Virginia Formation rock, which has a higher hydraulic conductivity than other bedrock at the site[147] (and also incidentally is more likely to generate acid).[148] While these factors do not necessarily indicate that polluted water would reach the river stretch to the north in a shorter time, the point is that the data for such an analysis was never collected.

The lack of a detailed hydrogeological study for the NorthMet project also resulted in the acknowledged inability to determine drawdown of the water table in wetlands due to the cone of depression from mine dewatering.[149] In this geography (which is very similar to the geography in the Rainy River-Headwaters, just a few miles away across the Laurentian Divide), several square miles of wetlands could be lost as a result.[150]

The lack of a detailed hydrogeological study also resulted in an inability to estimate the potential decrease in streamflow in the Partridge River. While the EIS acknowledges that the cone of depression could have an effect on streamflow, the quantitative estimate of reduction in streamflow is based only on loss of surface watershed area, and ignores the cone of depression.[151]

Inaccurate bulk characterization of a site can also result in significant errors in mine planning, which in turn can result in unanticipated impacts. One potential result is that the mine operator will have more contaminated water to manage than anticipated due to greater-than-expected inflow to the mine. Often this poor-quality water is accidentally or purposefully released to the environment due to insufficient storage and treatment capacity. The North Atlantic Division Regional Center of Expertise for Groundwater Modeling (U.S. Army Corps of Engineers) reviewed work done for the NorthMet mine specifically (and only) to address this issue. It found that the hydrogeological study for that project was adequate for the purpose of sizing the water treatment facility *only* because the amount of water from other sources that would need to be treated was so large that the contribution from mine dewatering was insignificant.[152] The first proposed mine plan for the Rainy River Headwaters (the Twin Metals Maturi project) does not

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[144] *E.g.,* NorthMet FEIS 5-5.
[145] All flow from the Category 1 Stockpile was modeled as contained and collected by an underground barrier.
[146] NorthMet FEIS 5-41, Table 5.2.2-8, A-651.
[147] NorthMet FEIS 5-37.
[148] NorthMet FEIS 5-60.
[149] NorthMet FEIS 5-259 to -260.
[150] NorthMet FEIS 5-283.
[151] NorthMet FEIS 5-111 to -113, -135, and A-293.
[152] North Atlantic Division Regional Center of Expertise for Groundwater Modeling (2016). *Final Review of NorthMet Mine Site MODFLOW Model*. U.S. Army Corps of Engineers, Philadelphia District.

include a treatment facility,[153] and an error in estimating mine inflow there could have enormous consequences.

The Mount Polley Mine in British Columbia provides an example of a mine that was permitted based on an inaccurate water balance study.[154] The mine was originally permitted as a "zero discharge" mine; when it became clear after mining began that a discharge would be necessary, the company obtained a low-volume permit that required treatment with reverse osmosis.[155] Treatment capacity proved insufficient, and the tailings basin was repeatedly filled beyond its design capacity. Although overfilling was not the primary cause of the catastrophic dam breach at Mount Polley, it was a primary reason for the size and extent of the disaster.[156] Following the dam breach, the mine operator obtained a permit for a larger discharge using a less expensive and less effective form of treatment; Lake Quesnel—formerly one of the highest quality waters in British Columbia—now has a significant mixing zone to bring pollutants in Mount Polley discharge down to water quality standard levels.[157]

The inadequacy of the hydrogeological investigation for the NorthMet Mine is reflected by statements from the Army Corps of Engineers review of mine inflow and water treatment capacity cited above:

> This model is not an appropriate tool for investigating or predicting drawdown due to operations dewatering or flow conditions post-closure. It is unclear how these predictions were used in or affect the final conclusions of the FEIS.
>
> This model is not valid for investigating or predicting flow paths from the pits, drawdown during dewatering or post-closure groundwater conditions. The majority of the uncertainties discussed in this review have little impact on the flow calculations for the purpose of sizing a treatment plant, but may have significant impact on other uses for the model.
>
> [T]he Barr MODFLOW mine site model is not an appropriate tool for predicting post-closure flows, including to the north.
>
> There is limited data on hydraulic conductivity in some units. The data that does exist shows wide variability. Adjustments within wide ranges will ensure the consideration of all possibilities. It will be especially important to adjust the vertical hydraulic conductivity of the surficial aquifer – even beyond the range considered reasonable by Barr Engineering. [158]

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153 Twin Metals Minnesota (2019b).
154 Koop, W. (2014). *A preliminary analysis and history of the Mount Polley mine tailings storage facility*. B.C. Water Tap Alliance.
155 Amnesty International (2017). *A breach of human rights: The human rights impacts of the Mount Polley Mine disaster, British Columbia, Canada.*
156 Chambers, D.M. (2015). *A review of the "Report on Mount Polley tailings storage facility breach, Independent Expert Engineering Investigation and Review Panel."* Center for Science in Public Participation.
157 Hosgood, A.F. (2021, Aug. 4). Seven years after Mount Polley disaster, mine waste still flows into Lake Quesnel. *The Tyee.* https://thetyee.ca/News/2021/08/04/Seven-Years-After-Mount-Polley-Disaster-Mine-Waste-Still-Flows/
158 North Atlantic Division Regional Center of Expertise for Groundwater Modeling (2016).

5. The level of hydrogeological understanding accepted by MDNR is also insufficient for monitoring, remedial action, and design and installation of mitigation measures

In the opinion of the MPCA in the context of solid waste disposal, a detailed understanding of hydrogeology is also necessary to design a monitoring plan that will detect polluted groundwater migrating from a site with worse water quality or in higher quantities than expected.[159] An EPA review of groundwater barrier systems also noted inadequate monitoring as a substantial issue, and found that tighter spacing of monitoring wells is particularly important in areas with bedrock fracturing. A survey of the 36 sites included in the EPA review found an average spacing of 500 linear feet, with a range of 50 to 1,440 feet.[160]

A failure to investigate (and therefore to identify) bedrock fracturing results in a failure to know when tighter spacing is needed. The extent of bedrock fracturing at the NorthMet site was a question explicitly left unknown, and monitoring wells will be spaced about 2,000 feet apart.[161] MDNR and MPCA reason that monitoring will detect problems if fracturing exists, but the monitoring wells are set too far apart to ensure the detection of problems in fractured geology.

A detailed understanding of hydrogeology can also prove essential when remedial action becomes necessary. As the U.S. EPA points out:

> Determining the location and magnitude of contaminant discharges to surface waters from groundwater plumes is a complex hydrogeological and biogeochemical problem. Although measurements of hydraulic gradient may be sufficient to delineate large discharge areas, numerous seepage studies have shown that areas of significant discharge can be small and easily missed. Even in relatively homogeneous terrain, flows may be highly focused at shorelines, and solute transport may be rapid. Geochemical conditions and contaminant concentrations may change drastically over intervals of a few centimeters.[162]

The MPCA Statement of Need and Reasonableness for Minnesota's solid waste rules quoted above makes the point that if hydrogeologic investigation has not adequately defined groundwater flowpaths, "there is little chance for success in tracking leachate movement if it escapes the engineered containment system."[163]

The Buckhorn Mine in Washington is another mine that was permitted based on a limited bulk hydraulic conductivity assessment. Like MDNR regarding the NorthMet Mine, the Washington Department of Ecology reasoned that if assumptions regarding hydrogeology proved false, adaptive management measures could be implemented to take care of any problems.[164]

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159 MPCA (1988).
160 U.S. EPA (1998, Aug.). *Evaluation of subsurface engineered barriers at waste sites.*
161 *See* MPCA (2018a). *National Pollution Discharge Elimination System/State Disposal System MN0071013*.
162 U.S. EPA (2000, July). *Proceedings of the Ground-Water/Surface-Water Interactions Workshop*.
163 MPCA (1988).
164 Wash. Depart. of Ecology (2006). *Buckhorn Mountain project Final Supplemental Environmental Impact Statement.*

Unexpected water quality impacts began almost immediately after the mine began operating in 2008, but effective adaptive management measures have yet to be implemented. The mining company has instead opted for litigation, arguing that the Department of Ecology does not have sufficient evidence as to the source of the pollution to require remedial action.[165,166]

Finally, a detailed understanding of the geology and hydrogeology of a site is necessary to determine whether proposed mitigation methods will be successful. Most modern mine plans include groundwater barrier systems to contain contaminated groundwater;[167] effective installation of these systems is highly dependent on the geology of the site. The EPA groundwater barrier review states very strongly that an adequate key into bedrock is essential to the efficacy of groundwater barriers. “The greatest difficulty in achieving adequate key depth was encountered at sites at which fractured bedrock occurred at depths of more than 70 feet below ground surface.”[168] As noted above, fracturing in Duluth Complex rock is considered to be extensive in the upper 200 to 300 feet of bedrock, making the effectiveness of groundwater barriers particularly questionable for this region. If fracturing is never investigated, regulatory agencies are likely to accept a mining company’s reliance on a barrier wall to contain polluted groundwater when in reality that barrier wall has little chance of success.

In addition, large boulders in the glacial till confound barrier construction in this region. Regarding a nearby taconite facility in the same geology, a review by Fond du Lac Band of Lake Superior Chippewa staff found, “The US Steel-MINNTAC system was originally intended to extend to bedrock, but that proved impossible in some locations because of the presence of large boulders within the glacial till that hindered construction.”[169] Lehr (2014) echoes many of these issues in his evaluation of the possibility of effective groundwater barriers at the NorthMet site:

> One of the most important aspects of constructing a slurry wall that effectively blocks the flow of groundwater is the nature of the geologic materials into which the slurry wall will terminate.
>
> . . . .
>
> The geologic situation at the [NorthMet] Tailings Basin is not favorable for the typical slurry wall construction technique of keying the slurry wall into bedrock because the bedrock present at the Tailings Basin is granite. This type of rock cannot be easily excavated from the surface using typical slurry wall construction techniques. It is difficult to imagine how construction of an effective slurry wall could be accomplished in this geologic setting without completely dewatering the perimeter of the Tailings Basin,

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165 Golder (2018, Mar. 7). *Buckhorn Mountain Mine Adaptive Management Plans Water Year 2017*. Prepared for Crown Resources.
166 Wash. Pollution Control Hearings Board (2015, July 30). *Crown Resources Corp. v. Wash. Dept. of Ecology*, PCHB No. 14-018, Findings of Fact, Conclusions of Law and Order.
167 The Maturi mine plan includes a “groundwater cutoff wall” to prevent seepage to groundwater from unlined ditches around its tailings facility. Twin Metals Minnesota (2019b), lines 1350 to 1355.
168 U.S. EPA (1998, Aug.).
169 Schuldt, N. (2014). Letter to Fay, L., MDNR, Bruner, D., U.S. Army Corps of Engineers, and Jiminez, M., Superior National Forest. (Citations omitted.)

> followed by the blasting of a trench into the Giants Range Granite that would serve as the "key" into which the slurry wall would be sealed.
>
> Further complicating construction of any type of seepage containment system at the Tailings Basin would be the presence of a very boulder-rich glacial till (Figure 3). In fact the boulder-rich characteristics of this particular Rainy lobe till are so obvious that researchers from the U.S. Geological Survey named it "the bouldery till" (Winter, 1971; Winter *et al*, 1973). The high percentage of boulders present in this till caused numerous problems in penetrating certain zones during field tests carried out at the Tailings Basin (Pint and Dehler, 2008; PolyMet, 2013n) and at the Mine Site (Barr, 2006b). One additional challenge posed by the presence of boulder-rich till in the construction of a slurry wall around certain portions of the Tailings Basin would be the inability to determine whether slurry wall excavation has actually encountered bedrock or possibly just a very large boulder in the till (Figure 3). Barr's (2007g) report to PolyMet on the construction of seepage capture systems at the Tailings Basin recognizes that slurry walls are not suitable if boulders or cobbles are present. The details of how an effective slurry wall system could be constructed at the Tailings Basin - one that takes into account actual field geologic conditions - seems to be missing from the SDEIS and supporting documents.

Despite many objections from many quarters, MDNR was willing to assume that groundwater barriers at the NorthMet site would be perfectly keyed to bedrock for distances stretching for several miles, with no investigation or analysis of potential issues presented by geology.

In summary, a fundamental problem with the uncertainty that arises from the practical impossibility of conducting a thorough hydrogeological study is that it results in the approval of projects for which the impacts are simply unknown. This is not acceptable for our most pristine and highly protected waters. The impossibility of accurately characterizing hydrogeology at sites in the Duluth Complex is reason enough why sulfide-ore copper mines should not be allowed in the Rainy River-Headwaters. Northeastern Minnesota is our nation's richest area in freshwater resources, and one of the richest areas on the planet; it is thus a place where failure to characterize hydrogeology accurately is likely to result in the greatest harm. In the Rainy River-Headwaters, inaccurate hydrogeological assessment will also translate into high risk to the BWCAW.

f. Non-acid producing rock can also leach high levels of sulfate and metals, and has been known to do so in northeastern Minnesota

Even when rock does not turn acidic, it can leach high levels of metals and sulfate into surrounding waters. This has been a particular problem in northeastern Minnesota with non-acid-generating ore and waste rock at taconite mines. The history of pollution from the Minntac tailings basin discussed above provides an example of the difficulties of dealing with sulfate pollution in neutral conditions.[170] Abandoned taconite pits are also sources of sulfate to downstream waters:

[170] MPCA (2016a). National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program Fact Sheet, Permit Reissuance MN0057207.

> Downstream of Colby Lake, sulfate concentrations increase as the result of groundwater seepage into the surficial aquifer from inactive mine pits (e.g., Pit 6 with a sulfate concentration of about 1,200 mg/L) and overflow from inactive mine pits (i.e., Pit 2W, which discharges intermittently at about 4.5 cfs with a sulfate concentration of approximately 125 mg/L).[171]

Rock that is deemed "low sulfur" can also leach metals. "Neutral to alkaline drainage waters may carry exceptionally high contents of metals such as zinc, molybdenum or cadmium and metalloids such as arsenic, antimony or selenium."[172] A site in Australia was found to leach very high levels of copper, nickel, and manganese despite a neutral pH.[173] In the Duluth Complex near the Maturi site, an abandoned bulk rock test site on Filson Creek leaches high levels of nickel, cobalt, and copper at a pH level of 6.4 to 7.0; other nearby sites on the creek had lower (more acidic) pH levels but also much lower concentrations of metals.[174,175]

Sulfide ore copper mines produce very large volumes of both acid-generating and non-acid-generating waste rock. Concern is generally focused on acid-generating rock because of the extreme pollution that it can generate. Non-acid-generating materials (including both waste rock and excavated peat and mineral soils) are often overlooked as a source of water pollution and not subject to sufficient controls.

Twin Metals proposes to treat reclamation material (peat and mineral soil) stockpiles as "noncontact" areas where runoff to surface waters and seepage to groundwater is allowed, as was done at the PolyMet site. Twin Metals also applies the "noncontact" designation to areas of the tailings facility that would be covered with this material or would leave it exposed before tailings are deposited, and to other areas where it would be uncovered by and/or used in construction. As discussed in the following section below, peat stores high levels of mercury that are likely to be released in leachate and runoff from stockpiles and construction areas.

g. Land clearing and deforestation in furtherance of sulfide-ore copper mining would also negatively impact water

Land clearing and earth moving in furtherance of sulfide-ore copper mining would degrade stream and river health and pollute surface waters. Loss of substantial areas of forest cover would reduce the capacity of land and stream/river systems to handle major precipitation events. Less interception and infiltration and more runoff would create more extreme stream and river hydrographs and reduce low flow volumes. More extreme high flows and hydrographic

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[171] NorthMet FEIS 6-44.
[172] Parbhakar-Fox, A., & Lottermoser, B.G. (2015). A critical review of acid rock drainage prediction methods and practices. *Minerals Engineering, 82,*107–124. http://dx.doi.org/10.1016/j.mineng.2015.03.015.
[173] Australian Government Dept. of Industry, Tourism and Resources (2016). *Preventing Acid and Metalliferous Drainage*. https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-preventing-acid-and-metalliferous-drainage-handbook-english.pdf.
[174] Butcher, J.T. (2011, April 20). *Technical memo re: Water quality/quantity evaluation on 10/29/2010*. U.S. Forest Service. Appendix 2.
[175] *Preliminary report Spruce Road bulk sample site monitoring results.* (1977, May 26). Prepared for Minn. Environmental Quality Board Copper Nickel Study.

flashiness translates to higher stream energy, degraded stream bank and channel stability, increased erosion, and water pollution problems including increased turbidity, suspended sediment, nutrient loading, and biological oxygen demand.[176] Disturbing peat and mineral soils releases stored mercury, resulting in increases in surface waters that are already impaired for that pollutant.

1. Development and deforestation would result in increased pollutant loads to surface waters

Even in the absence of specific mishaps and events, runoff and groundwater infiltration from disturbed land (construction areas, cleared or developed land, and/or impervious surfaces) result in incremental degradation of surface waters, and can also result in periodic violations of water quality standards, especially during snowmelt or heavy rains.[177,178] Impervious surfaces not only increase polluted run-off, but decrease groundwater recharge and subsequent baseflow to streams,[179,180,181] adding to decreases due to mine dewatering. Decreased baseflow tends to worsen water quality, as baseflow usually is of better quality than runoff.

Modeling undertaken for MPCA's Draft Rainy-River Headwaters Watershed Restoration and Protection Strategy[182] (hereinafter, "WRAPS") is premised on the understanding that development and change in land cover results in significant increased load of pollutants to lakes and streams. This is true of any development, but a single mine disturbs more acreage than other types of development.

Mine operations rely on construction and industrial stormwater general permits for discharge of this water.[183] General permits cover discharges from all activities of a particular type (e.g., construction), eliminating the need for an individual discharge permit. These permits typically require the use of "best management practices" (BMPs) rather than actual compliance with water quality standards. That is, BMPs are assumed to result in compliance with water quality standards. In some cases, however, they do not. At the Buckhorn Mine, for example, a series of

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[176] MPCA (2006). Understand your watershed: Hydrology and geomorphology. In *Setting the course for improved water quality*. https://www.pca.state.mn.us/sites/default/files/wq-iw3-50-5.pdf
[177] MPCA (2019, Nov.). *Stressors candidate causes: Stressors to biological communities in Minnesota's rivers and streams.*
[178] Line, D.E., & White, N.M. (2007). Effects of development on runoff and pollutant export. *Water Environment Research, 79*, 185-190. www.jstor.org/stable/23803222
[179] Liu, Z., Wang, Y., Li, Z., & Peng, J. (2012). Impervious surface impact on water quality in the process of rapid urbanization in Shenzhen, China. *Environmental Earth Sciences*, *68*, 2365–2373. https://doi.org/10.1007/s12665-012-1918-2
[180] New Hampshire Estuaries Project (2007). *The impacts of impervious surfaces on water resources, NHEP*. University of New Hampshire. https://scholars.unh.edu/prep/236
[181] Hurd, J.D., & Civco, D.L. (2004). *Surface water quality and impervious surface quantity: A preliminary study*. [Project completion report for NOAA Grant NA16OC2673]. Center for Land Use Education and Research, University of Connecticut.
[182] MPCA (2021, Aug.). *Draft Rainy River-Headwaters Watershed Restoration and Protection Strategy Report.*
[183] *See* Twin Metals Minnesota (2019b) lines 1585-1589 ("Construction activities would be conducted in accordance with the Minnesota Construction Stormwater General Permit, following best management practices (BMPs) ….")

BMPs instituted under a general permit have repeatedly proven insufficient to prevent exceedances of water quality standards.[184]

Furthermore, BMPs are meant to minimize pollution only to the extent necessary to meet water quality standards. Degradation of high-quality waters up to the point of water quality standards is accepted. In the Rainy River-Headwaters, this means that waters will be allowed to degrade in Birch Lake and its tributaries from construction and development as a matter of course, without consideration of the current high quality of these waters and despite the non-degradation standard downstream.

The WRAPS project modeled the potential increased load of sediment, nitrogen, and phosphorus under development, forest disturbance, and climate change scenarios that could result regardless of the reason for these stressors. The results clearly indicate that *any* development of the size that would result from mining would significantly increase loads of these pollutants to downstream waters. Sulfate, mercury, and other heavy metals were not modeled, but all indications are that they would also increase.

The WRAPS Report indicates that Birch Lake and the lakes immediately downstream comprise one of the three most impacted and at-risk areas in the watershed from development of any kind. Table 2 of the report indicates that Birch, Farm, and Garden Lakes[185] are the only lakes in the watershed with degrading trends in transparency based on recent Secchi disk monitoring.

The WRAPS Report assesses the potential impacts and risks to water resources from increased development and forest disturbance regardless of the cause. The report focuses on private lands and lands within 500 feet of shorelines of residential lakes, and assumes a certain percentage of development in these land classifications. The assessment did not consider the potential that a greater percentage of private lands to the south and east of Birch Lake will be developed (and the forest converted) for mining, or that significant areas of what are now public lands are also threatened by development and forest conversion for mining.

Even leaving mining out of the equation, the report indicates that Birch Lake and its downstream lakes are the part of the watershed most at risk from future development. Figure 26 of the report shows the mining-impacted Dunka watershed as the only subwatershed in the Rainy River-Headwaters that is at risk of a greater than 95% increase in sediment runoff; the modeled potential increase is 305%. This subwatershed along with two adjacent ones, one of which is Birch Lake, are the only three subwatersheds at risk of a greater than 50% increase in sediment runoff. It could not be more clear that this portion of the watershed needs a level of protection from the impacts of development that it does not currently have.

Increased pollutant load due to forest loss and land clearing is a cumulative issue. Permitting in Minnesota does not provide a mechanism to stop the cumulative decline in water quality or other resources once it begins. The cumulative effects of forest loss and land clearing from multiple

[184] Golder (2018, Mar. 7).
[185] Farm and Garden Lakes are downstream of Birch Lake prior to entry to the BWCAW. Current impacts to these lakes are due primarily to residential development. Increased mining in the Birch Lake area would have impacts that are cumulative to residential development.

mines as well as other types of development is thus an issue that must be addressed for the watershed as a whole before any individual mine goes through the permitting process. The WRAPS process is based on the premise that assessing and addressing cumulative impacts is necessary for watershed protection, but the Rainy River-Headwaters WRAPS process will not address contributions from mining.

2. Land clearing for mining would increase mercury and sulfate in surface waters, resulting in increased mercury in fish

Land clearing and the use of excavated soils for construction will increase the load of mercury and sulfate to area waters. Sulfate is ubiquitous in both rock and soil, and ground disturbance at the scale involved in large mines will inevitably release sulfate to surface waters.

In addition, any mining project in the Duluth Complex will release additional mercury to area waters. Topsoil, mineral soil, and peat all store mercury. Excavating and moving these materials into stockpiles greatly enhances the potential movement of mercury into surface water.[186] Peat is known to sequester mercury and to release it when excavated and exposed to wetting and drying.[187] In leach tests of peat soils that would be stockpiled at the NorthMet Mine, leachate water had a mercury concentration as high as 18 ng/L.[188] Mineral overburden materials released leachate with mercury as high as 16 ng/L. This is significantly higher than rainwater, which at the nearest monitoring site from 2011 to 2017 averaged about 9 ng/L.[189]

Any mine in the Duluth Complex would involve the disturbance, exposure, excavation and stockpiling of peat and mineral soils. As an example, the Maturi Mine would include two stockpiles of excavated material at the plant site holding an estimated 85,000 cubic meters and covering an area of about five acres.[190] A third stockpile for the dry stack tailings facility would hold 671,000 cubic meters covering sixteen acres.[191] The latter stockpile would be used to construct the cover for the dry stack tailings facility, which would then be exposed to precipitation and resultant leaching for many years to come. Land clearing would also be necessary for access roads, the water intake corridor, ponds and ditches, and the ventilation raise areas.[192] Both the cleared areas and the excavated materials could be expected to result in mercury leaching to nearby waters.

It appears that Twin Metals does not intend to line these stockpiles; MDNR and MPCA did not require liners for similar stockpiles at NorthMet. While runoff from the Twin Metals stockpiles

[186] Grigal, D.F. (2003). Mercury sequestration in forests and peatlands. *Journal of environmental quality, 32*, 393-405. DOI: 10.2134/jeq2003.3930.
[187] Coleman Wasik, J.K., Engstrom, D.R., Mitchell, C.P.J., Swain, E.B., Monson, B.A., Balogh, S.J., Jeremiahson, J.D., Branfireun, B.A., Kolka, R.K., & Almendinger, J.E. (2015). The effects of hydrologic fluctuation and sulfate regeneration on mercury cycling in an experimental peatland. *Journal of Geophysical Research: Biogeosciences, 120,* 1697-1715. https://doi.org/10.1002/2015jg002993.
[188] PolyMet Mining Co. (2015, Feb. 13), Table 3-1, p. 4.
[189] National Atmospheric Deposition Program (2020). Mercury Deposition Network data for Site MN18 (Fernberg) [Excel spreadsheet]. Retrieved on April 6, 2020 from http://nadp.slh.wisc.edu/data/sites/siteDetails.aspx?net=MDN&id=MN18
[190] Twin Metals Minnesota (2019b) lines 754-760 and Table 2-8.
[191] *Id.* lines 991-994 and Table 2-10.
[192] *Id.* lines 1442 to 1444; Figures 2-4 (access roads); 2-8 (water intake corridor); 2-15 (contact water ditches).

would at times be collected for use as process water, during storm events the company plans to release the runoff directly to the environment.[193] This is precisely the time when runoff is likely to carry the most mercury.

In addition to the disturbance and stockpiling of soil materials, all mines involve clearing large areas that are currently forested. Deforestation is known to result in increased mercury levels in surface water, as it increases both the rate of runoff of precipitation and the exposure of peat and mineral soils to runoff water.[194,195,196] Precipitation is itself high in mercury, exceeding water quality standards. Movement of precipitation through vegetation and soils can provide attenuation, which is significantly decreased in disturbed and/or deforested watersheds. Furthermore, mining operations in the Duluth Complex will remove enormous amounts of water from systems of natural attenuation to systems of artificial collection and movement, with the result that mercury originating in precipitation will reach surface waters at higher levels.

The combination of increased mercury and sulfate entering wetlands, lakes, and streams would result in increased mercury methylation and ultimately, higher levels of mercury in fish, both in Birch Lake (a very popular fishing lake) and downstream in the BWCAW. The role that sulfate plays in mercury methylation (and thus in mercury levels in fish tissue) and the impacts of mercury and sulfate on aquatic systems are discussed below in Part 2, Section C.II.g.

Regulators do not treat water contacting peat or other disturbed soils as “mining-influenced” water; discharge of this water to surface waters is permitted under existing statewide general permits, without assessment of the impacts on receiving waters at the specific site. The use of general permits to allow discharge of this water is one of the issues that resulted in federal and state investigations into the MPCA and EPA handling of the NorthMet NPDES permit. EPA staff insist that construction activities at that site do not fall within the parameters of the construction general permit because of potential releases of mercury. Kevin Pierard, Chief of the NPDES Program Branch of EPA Region 5, referred to this as one of the two most objectionable aspects of MPCA’s handling of PolyMet discharges: “MPCA’s plan to issue general permit coverage for construction stormwater discharges from peat dominated wetland systems which may release significant amounts of mercury into downstream navigable waters.”[197]

We quote at length from the Pierard memo:

> MPCA representatives . . . refused to make any changes to address the expected mercury loading anticipated from stormwater runoff from the removal of peat dominated wetlands

[193] *Id.* App. C, Non-contact water management plan, lines 91-94.
[194] Hsu-Kim, H., Eckley, C.S., Achá, D., Feng, X., Gilmour, C., Jonsson, S., & Mitchell, C.P.J. (2018). Challenges and opportunities for managing aquatic mercury pollution in altered landscapes. *Ambio, 47*, 141-169. doi:10.1007/s13280-017-1006-7.
[195] Gamby, R.L., Hammerschmidt, C.R., Costello, D.M., Lamborg, C.H., & Runkle, J.R. (2015). Deforestation and cultivation mobilize mercury from topsoil. *Sci. Total Environ., 532*, 467–473. doi:10.1016/j.scitotenv.2015.06.025.
[196] Ruzycki, E.M., Axler, R.P., Henneck, J.R., Will, N.R., & Host, G.E. (2011). Estimating mercury concentrations and loads from four western Lake Superior watersheds using continuous in-stream turbidity monitoring. *Aquatic Ecosystem Health & Management, 14*, 4, 422-432. DOI: 10.1080/14634988.2011.624863
[197] Pierard, K. (2018, Dec.). Memorandum to File, re: Review Summary of Poly Met Mining, Inc., NorthMet Proposed NPDES Permit (MN0071013).

> and plan to cover this discharge under the State's construction stormwater general permit. The construction stormwater general permit does not include provisions for addressing specific water quality standards issues. As a result, the proposed permit (and associated permitting scheme) appears to leave mercury from this aspect of the project wholly unregulated. EPA Region 5 recommended that MPCA evaluate whether there is reasonable potential for discharges covered under the construction stormwater general permit to cause or contribute to excursions from water quality standards and whether such discharges could be controlled as a part of the State's CWA Section 401 certification. There is nothing in the permitting record to suggest that MPCA has performed this analysis. Therefore, construction stormwater general permit coverage, which presupposes that a project will comply with WQS, likely would not be sufficient to ensure discharges of construction stormwater from peat removal activities, which have been shown to release mercury at other Minnesota industrial facilities, will comply with downstream water quality standards in this case.

h. Sulfide-ore copper mines in the Duluth Complex would involve low-grade, high-volume ore and disposal of high-volume waste

Sulfide-ore copper mines located in the Rainy River-Headwaters would mine disseminated, low-grade ore. Mining such low-grade ore is economically viable only when mining operations are very large, taking advantage of economies of scale. These mines excavate high volumes of ore and necessitate the disposal of high volumes of waste.

In addition, large mines require management and discharge of high volumes of contaminated water. All of the pollution issues that arise from mining processes are exacerbated by the enormous volumes of water involved. As the EPA has pointed out, "The scale of these mining operations poses formidable obstacles to effectively and efficiently addressing releases."[198]

Many of the more recent mines that we draw on for examples of water quality issues that frequently develop at mines are much smaller than the mines that are being considered for the Rainy River-Headwaters. The proposed Maturi mine would process about 20,000 tons of ore per day. In comparison, the Flambeau and Buckhorn mines each excavated 1,000 tons per day; Greens Creek and Eagle mines process about 2,000 tons per day. The mining industry has not yet proven that it can operate even a very small mine without polluting water; the chances that it could operate several large mines in a landscape like that of the Rainy River-Headwaters is vanishingly small.

In addition to considering the ramifications of such large industrial mines and mining facilities in the Superior National Forest upstream of the BWCAW, the Withdrawal review should consider whether adequate environmental review is itself possible for mining projects of this size. As explained above, MDNR believes that a detailed hydrogeological study for such sites is not possible. As a consequence, the NorthMet project was permitted without identifying the level of impacts on wetlands or stream flow, and its assessment of impacts on water quality could be highly inaccurate. In contrast to what is usually required for a Clean Water Act Section 404

[198] U.S. EPA, Financial responsibility requirements under CERCLA § 108(b) for classes of facilities in the hardrock mining industry, 82 Fed. Reg. 3388 (Jan. 11, 2017).

(wetland fill) permit, only a very cursory wetland survey was done.[199] This is not surprising, as the survey had to cover many square miles.[200] Just as financial institutions become immune to regulation by being "too big to fail," mining projects become immune to regulation by being too big to study.

1. Large land areas would be affected

Any mine in the Duluth Complex will occupy and affect large areas of the landscape. The proposed Maturi Project, which is scaled down significantly from the company's initial plan,[201] would require close to two square miles of surface facilities, including an approximately one-square mile tailings facility.[202] The tailings pile would be 130 feet high,[203] towering over the forest. The mine operations would stretch four miles from north to south. The acreage of the underground mine footprint is not given in the mine plan, but appears to be three to four square miles.[204] The underground mine would be located under the very edge of the South Kawishiwi River and Birch Lake for a stretch of about two miles.

If mining of federal minerals or mining on federal property is allowed, several mines of equivalent size would likely be spread across the Birch Lake area and upstream to the Dunka area. Service roads will be needed that are able to withstand the trucking of mining equipment and mine output, as well as allowing for constant traffic of mine personnel. New power lines, pipelines, and other infrastructure would need to be constructed. These corridors would likely end up crisscrossing the entire Birch Lake/South Kawishiwi River area.

2. Lower grade deposits are problematic for the environment because a lower profit margin means less ability to afford environmental protections

The profitability of a mining operation has a direct relationship to the potential for environmental impacts. Measures designed to protect the environment can be costly, and often do not directly contribute to the recovery of metal. They are therefore a natural place for a company to cut corners if it is becoming unprofitable. Mines in the Duluth Complex will have a low profit margin, and thus will be more likely than average to develop problems.

The proposed Maturi mine can be used as an example. Twin Metals has chosen not to release financial information that is ordinarily available through the securities commission of the

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[199] *See Fond du Lac Band of Lake Superior Chippewa v. Stepp.* U.S. Dist. Ct., Minn. Dist., Case No. 19-2489, Complaint (Sept. 10, 2019), para. 107 to 110.
[200] Cooperating Agencies suggested a wetland analysis similar to what was done for the proposed Crandon Mine in Wisconsin, but were rebuffed. The Crandon Mine would have disturbed a total of 550 acres of land surface. *Environmental Justice Atlas* (2015, May 7). Proposed Crandon Mine in Northeast Wisconsin, USA. Retrieved Dec. 18, 2021 from https://ejatlas.org/conflict/proposed-crandon-mine-in-northeast-wisconsin-usa. This is a fraction of what would be disturbed at the NorthMet mine and less than half of what would be disturbed at the proposed Maturi Mine. The underground Crandon Mine would have been approximately one-third the size of the proposed Maturi Mine.
[201] Duluth Metals (2014, Oct.).
[202] Twin Metals Minnesota (2019b), Table 2.1.
[203] Twin Metals Minnesota (2019a), lines 935-938.
[204] *Id.,* Fig. 2.2

jurisdiction where a mining company is registered; the best publicly available information for the proposed mine is a six-year-old technical report that addressed a significantly different (and larger) mine plan than the one that has now been proposed.[205] This lack of information is itself problematic, as it means that government agencies and the public have no basis to judge whether the mine as planned would produce enough income to safeguard the environment.

The information that is available indicates that this is not an idle concern. The Maturi mine plan targets a mineral resource with a lower grade than any operating underground copper mine in the world. A 2016 review by the "Angry Geologist" (a well-known and respected but anonymous investment blogger) listed the four lowest-grade underground copper mines as ranging from 0.76% to 1.5% copper.[206] Three of the four mines also produced other metals, with the lowest copper equivalency grade of 1.04%.

In comparison, the Maturi deposit has an average grade of 0.69% copper,[207] with a copper equivalency grade of about 1%. A couple of factors make this even more concerning than it initially appears. First, most mines operating today began with higher grades of ore than they currently mine.[208] Generally speaking, mines that have been operating for some time are able to mine the same grade of ore for a lower cost. The mine that the Angry Geologist identified as the lowest-grade copper mine (Sierra Minerals' Bolivar Mine in Mexico) began mining in 2006 with a copper *cut-off* grade of 1% and a zinc cut-off grade of 6%, which equates to a copper equivalency grade of 3.4%.[209]

Second, none of the lowest grade underground copper mines are located in the United States. The existence of mines making a profit in Mexico or India cannot be taken as an indication that ore of a similar grade can be mined profitably in this country, where labor and other costs are substantially higher.

The NorthMet project is economically viable only because it is re-using an existing processing plant and tailings disposal facility and will mine ore that is relatively close to the surface in open pits.[210] PolyMet's 2018 NI 43-101 (Prefeasibility Study Report) indicates that at 2018 metal prices, the mine would show a profit of only 10%,[211] an extremely low margin to rely on when opening a new mine.[212]

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[205] Duluth Metals (2014, Oct.).
[206] The Angry Geologist (2016, Sept. 29). *The lowest grade mines in the world - copper*. Retrieved Nov. 21, 2021, from http://angrygeologist.blogspot.com/2016/09/the-lowest-grade-mines-in-world-copper.html.
[207] Twin Metals Minnesota (2019b), Table 2-11.
[208] Crowson, P. (2012). Some observations on copper yields and ore grades. *Resources Policy 37*, 59-72. https://doi.org/10.1016/j.resourpol.2011.12.004.
[209] Agnerian, H. (2005). *Technical Report on the Bolivar CU-ZN Project, State of Chihuahua, Mexico, NI 43-101 Report.* Prepared for Dia Bras Exploration Inc.
[210] MDNR, U.S. Army Corps of Engineers, & U.S. Forest Service (2013, Sept. 27). *Underground Mining Alternative Assessment for the NorthMet Mining Project and Land Exchange Environmental Impact Statement.* (NorthMet FEIS App. B.)
[211] Black, Z.J., et al. (2018). *NorthMet Project Form NI 43-101F1 Technical Report*. Prepared for PolyMet Mining.
[212] Basov, V. (2018, Sept. 17). Most profitable mining companies in 2017. *Mining.com*. https://www.mining.com/ranked-mining-companies-yielded-highest-profit-margins-2017/.

It is illuminating to compare the proposed Maturi Mine to the two other underground copper/nickel mines in the United States that are located in sensitive environments and have recently gone through permitting, Eagle Mine in Michigan and Black Butte Mine in Montana. Eagle Mine ore grades at an average 2.9% copper and 3.6% nickel,[213] and Black Butte grades at an average 3% copper.[214] Again, this is in comparison to 0.69% copper and 0.22% nickel for Maturi. Maturi would be a much larger mine and there would be economies of scale, but as an underground mine it is unlikely to overcome the extreme economic disadvantage of mining such a low-grade ore.

Furthermore, the increase in scale presents a comparable increase in environmental degradation. Twin Metals will need to excavate, process, and dispose of many times as much rock as the Eagle and Black Butte Mine do to produce the same amount of metal. If the Maturi mine or another project like it were to be built here, the public would be asked to accept an amount of environmental degradation that is out of line with other mines in sensitive areas.

In addition to the inherent large-scale impacts of a low-grade mine, permitting a potentially unprofitable mine courts disaster. First, the mine will almost certainly not be built and/or operate according to the mine plan, regardless of what permits say. For example, Twin Metals claims that to avoid long-term surface storage of sulfide-bearing waste rock, it will process waste rock as low-grade ore during the first two years of operation. This claim is contrary to typical mine planning; because the start-up of a mine is so capital-intensive, mining companies tend to adjust their mine plans to mine higher grade ore in the first few years, when a higher return is needed to offset costs.[215] Environmental and permitting review may consider a waste rock stockpile that exists for two years while it is processed as ore, but if the mine is less profitable than predicted that stockpile is likely to remain for far longer, possibly with a liner and leachate collection system that are inadequate to the task, and possibly with leachate quality that requires a treatment plant that does not exist.

If an unprofitable operation is actually built according to the plan that is permitted, the operator will immediately begin looking for ways to cut costs. Whether that means doing the work with fewer people or less skilled labor, using cheaper construction methods, or failing to clean sludge out of ponds to maintain their capacity, the company will be under pressure to lower its costs.

i. The potential for impacts extends for centuries or millennia after a mine closes

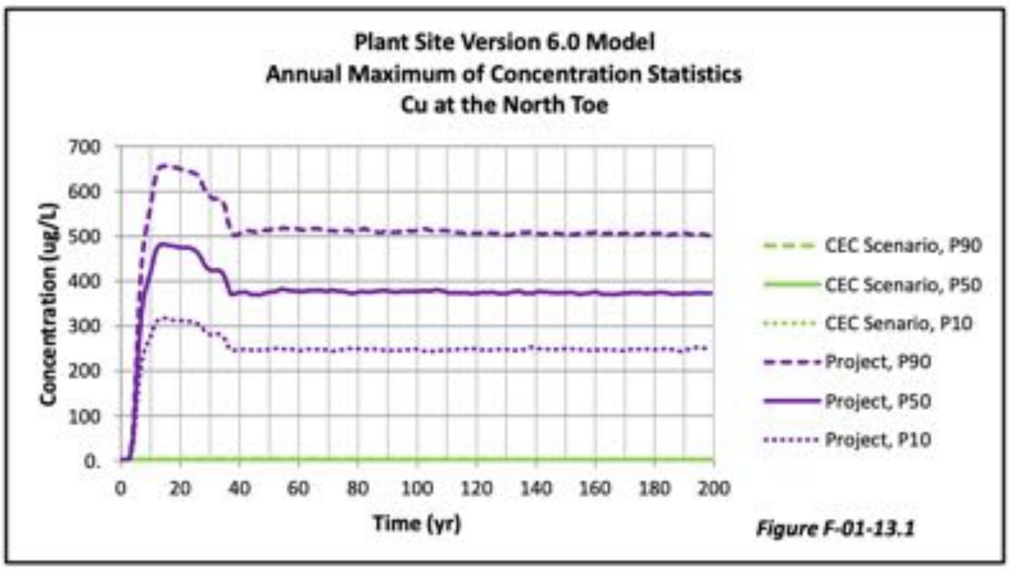
At many if not most sulfide-ore copper mines, mine pits, underground mine workings, tailings, and waste rock will continue to generate contaminated water for centuries or millennia after mining ends. The 2013 Earthworks Report "Polluting the Future" lists more than fifty mines that will generate pollution in perpetuity. [216]

[213] Kennecott Eagle Minerals (2006). *Eagle Project Mining Permit Application Vol. 1*, p. 17, Table 4-5.
[214] Mont. Dept. of Environmental Quality (2020). *Black Butte Copper Project Final Environmental Impact Study Executive Summary.*
[215] Mudd, G.M. & Jowitt, S.M. (2018). Growing global copper resources, reserves, and production: Discovery is not the only control on supply. *Economic Geology, 113,* 1236-1267. https://doi.org/10.5382/econgeo.2018.4590.
[216] Earthworks (2013). *Polluting the future: How mining companies are contaminating our nation's waters in perpetuity*.

1. Mining in the Duluth Complex is expected to produce pollution exceeding water quality standards indefinitely

Mines in the Duluth Complex will be added to the list. Although MDNR did not attempt to determine how long the NorthMet project will continue to generate pollution, modeling indicated that at year 500 at the plant site and year 200 at the mine site (i.e., the end of the modeled period), water will still need to be treated before discharging to the environment.[217] Note that this does not mean that treatment could potentially end at year 500, only that MDNR does not know how long after the initial 500 years treatment would need to continue.

Two-hundred-year graphed modeling data in the Water Quality Modeling Data Package for the NorthMet Mine EIS suggest that many pollutants would be generated at problematic levels for substantially longer than 200 years. The graphs include many trend lines indicating high pollutant levels that remain flat to the year 200, with no apparent end. An example from the tailings basin site is provided below:



Other similar graphs apply to copper, cobalt, and zinc at the backfilled East Pit,[218] and to sulfate and lead at the tailings basin.[219] These graphs indicate that water overflowing from the mine pits and seeping from the tailings basin will need to be treated before being released to the environment for a very long time. The mining industry objects to the word "perpetual," but it seems to us that perpetual is the appropriate word for a straight-line graph.

[217] NorthMet FEIS 5-8.
[218] PolyMet Mining Co. (2015, Feb. 27). *NorthMet Project Water Modeling Data Package – Vol. 1, Mine Site* (NorthMet FEIS ref. doc. PolyMet 2015m), Att. G, Figures G-09-11.2, G-09-13.2, and G-09-27.2.
[219] PolyMet Mining Co. (2015, March 13). *NorthMet Project Water Modeling Data Package – Vol. 2, Plant Site* (NorthMet FEIS ref. doc. PolyMet 2015j), Att. F, Figures F-01-21.1 and F-02-24.1.

2. Many jurisdictions are questioning the wisdom of permitting mines that will require perpetual treatment

David Chambers, the founder and president of the Center for Science in Public Participation, is certified as a professional geophysicist with a Ph.D. in environmental planning and a masters in geophysics. He has 40 years of experience in mineral exploration and development and 15 years of technical management experience in the mineral exploration industry. As Dr. Chambers points out:

> [I]t is not possible to quantitatively predict the probability of a water treatment plant failure. In general this is due to the fact that there is only a relatively short operating history of these facilities – a few have been in operation for 50 years or more, but the projected operating time frame for many water treatment plants is thousands of years. Even if we assume that treatment will never be affected by catastrophic weather events, human error, or other unforeseeable problems, there are two fundamental questions that must be answered in order to address the issue of the probability of water treatment failure:
>
> - first, can we correctly calculate what the long-term costs of treatment will be so that this money can be put aside during mine operation; and,
>
> - second, will the money set aside for water treatment in perpetuity be managed by a responsible organization in perpetuity?
>
> The Catholic Church and the Roman Empire are among the longest lasting institutions in human history, which itself has a self-documented history of 7,000 – 10,000 years. It is likely that treating some acid- generating waste may be required for longer periods than this, so whether it is even possible to have an institution that can account for funds, and/or be responsible for managing the treatment is questionable.[220]

Environmental review of a specific mine plan typically does not address the question of whether governments and other institutions can be expected to last long enough to ensure the continued maintenance and/or operation of systems to protect water after the mine closes. However, the same issue has been vetted in the context of storage and disposal of nuclear waste, with governments reaching the conclusion that long-term storage requiring ongoing maintenance is not an acceptable option. Quoting from the International Atomic Energy Agency:

> Since adequate protection of humans and the environment will continue only as long as maintenance is continued on storage facilities, and since some of the radioactive material in storage will remain hazardous for many thousands of years, maintenance — or institutional control — would be required for such periods of time or until permanent disposal is implemented. A review of world history reveals that turmoil and change usually occur in much shorter periods of time and therefore that it is unlikely that any

[220] Chambers, D.M. (2014). *The Potential for Acid Mine Drainage and Other Water Quality Problems at Modern Copper Mines Using State-of-the-Art Prevention, Treatment, and Mitigation Methods*. Center for Science in Public Participation.

> societal infrastructure currently in place or envisaged would last for the time period needed.[221]

Some mining jurisdictions are grappling with the fact that permitting a sulfide-ore mine may mean approving a project that will need to operate a water treatment plant in perpetuity. Colorado recently passed legislation requiring mining companies to prove that they will not need perpetual water treatment after a mine closes as a condition of permitting.[222] Michigan has a similar regulation.[223] At a 2019 hearing on a permit for a Nevada mine, the Nevada State Environmental Commission ruled that it was required to issue a permit under current regulations. However, all three members of the Commission expressed reservations, with one stating, "We're going to be gone when the impact of this would be felt. In Nevada for too long we've probably ignored some of the consequences."[224] The legal situation in Minnesota is murky. Although the rules seem to require a mine plan that does not rely on indefinite water treatment,[225,226] MDNR seems not to interpret them in that way.

A primary difficulty with legislation or regulations like those in Colorado and Michigan is that mining companies often do not determine that they will need perpetual treatment until after mining has begun. While many mining companies initially predict that perpetual treatment will not be needed, it is a rare mine that does not continue to produce impacted water after reclamation.

Perhaps hoping to avoid the question, Twin Metals has proposed a "zero discharge" mine. But zero discharge is another goal that is often touted but rarely achieved.[227,228] The history of zero discharge mine plans suggests that it is more a strategy to get a mine permitted than an actual expectation. Once a mine is excavated and groundwater is contaminated, it is not difficult to get approval for perpetual treatment. At that point, the only alternative is to discharge contaminated water directly to the environment.

3. Perpetual pollution has implications beyond the need for a permanent treatment plant

Water treatment is not the only system that will have to operate in perpetuity at most mines. A typical mine plan relies on liners, caps, and containment walls to prevent contaminated

[221] International Atomic Energy Agency (2003). *The long-term storage of radioactive waste: Safety and sustainability*.
[222] Colorado HB19-1113, Protect Water Quality Adverse Mining Impacts Bill, retrieved April 1, 2021 from https://leg.colorado.gov/sites/default/files/2019a_1113_signed.pdf.
[223] Mich. R. 425.204(b)(vi).
[224] Solis, J. (2019, Sept. 5). "Deeply concerned" but citing state law, panel upholds mine's water permit. *Nevada Current*. https://www.nevadacurrent.com/2019/09/05/deeply-concerned-but-citing-state-law-panel-upholds-mines-water-permit/.
[225] Minn. R. 6132.2200, subp. 2.B. (waste must be stored or modified so that it is no longer reactive, or "substantially all water" must be prevented from moving through it).
[226] MDNR (n.d.b). *Nonferrous metallic mineral mineland reclamation rules statement of need* ("Another method, that consists of merely collecting contact water and treating it in order the [sic] meet water quality discharge standards, without a substantial effort to minimize the amount of water contacting the waste, has been rejected.")
[227] Earthworks (2012). *False Promises: Water Quality Predictions Gone Wrong—Large Mines and Water Pollution*.
[228] Kuipers, et al. (2006).

groundwater from discharging to surface waters over the centuries. But how long will even the most well-constructed and installed liner, cap, or containment wall last?

These facilities all degrade over time, but very little has been done to answer this question. Most recent mines have been permitted under the assumption that geomembrane liners buried under other material will degrade by about 50% over 400 years.[229] Recently, however, researchers are questioning this conclusion. Tuomela et al. (2021) state that in regard to degradation time, "[l]ittle information is currently available because of suspicions that high sulfate content and very high salinity can reduce the durability of geomembranes." And, "Some studies have expressed concerns about the long-term behavior of clay liners and layers, which are not believed to be as reliable in composite structures as the calculations suggest."[230]

An EPA review of groundwater barriers explicitly and repeatedly reports that no information is available on their long-term effectiveness or their likelihood of breaking down over time:

> Essentially no long-term monitoring of physical samples was performed to examine mechanisms of degradation affecting the barrier.
>
> [M]ost barriers in the study have been in place for fewer than 10 years; therefore, long-term performance can only be extrapolated.
>
> Most remediation projects at hazardous waste sites use a design life of 30 years. The durability of construction materials used to install barrier walls at contaminated sites still is being evaluated for that period.
>
> Monitoring environmental degradation of barrier construction materials is not practiced widely. . . . . Degradation mechanisms can include chemical attack (for example, a high concentration of chlorinated solvents), inhibited bentonite hydration caused by saline or hard water, desiccation of earthen barriers in a cyclic vadose zone, and corrosion of metal-sheeted structures. The established industry baseline standard for postconstruction degradation monitoring is that none is performed.
>
> [A]t only 2 of the sites studied was the barrier reevaluated to assess long-term degradation of the barrier or contaminant breakthrough. The two studies were prompted by the identification of other problems related to the barrier.
>
> Testing for long-term degradation, physical sampling for diffusion through the barriers, and testing for the effect of desiccation on permeability effectively were absent.
>
> Unfortunately, for many of the sites, data are insufficient to determine long-term performance.

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[229] This estimate appears to be universally based on work reported in Koerner, R.M., Hsuan, Y.G., & Koerner, G.R. (2011). *Geomembrane lifetime prediction: Unexposed and exposed conditions*. Geosynthetic Institute.
[230] Tuomela, A., Ronkanen, A.-K., Rossi, P.M., Rauhala, A., Haapasalo, H., & Kujala, K. (2021). Using geomembrane liners to reduce seepage through the base of tailings ponds—A review and a framework for design guidelines. *Geosciences*, *11*, 93. https://doi.org/ 10.3390/geosciences11020093.

> This study represents a majority of the sites that have been in operation for less than 10 years. It is difficult to extrapolate this performance evaluation for the 30-year design life of the barrier because of physical and chemical degradation of the backfill resulting from site contaminants.
>
> In the 36 sites studied, monitoring systems for subsurface engineered barriers lack consistency in terms of scope, design, and implementation. This results in lack of credible data that can be used to evaluate performance. This study shows the need to standardize the design and implementation of monitoring systems. This need becomes even more crucial for engineered barriers used for long-term containment.
>
> [P]ostconstruction analysis of chemical breakthrough and degradation was reported for only 2 of the 36 sites studied. At no site were periodic long-term degradation monitoring data collected.[231]

Fifteen years after the EPA report, the use of groundwater barriers was beginning to be required for mines in many jurisdictions, but there were still no studies and no data on their long-term effectiveness or likelihood of breaking down. A 2013 industry paper that encourages the use of such systems had this to say:

> There is a paucity of long-term (>10 years) monitoring information that demonstrates the ongoing integrity and efficiency of LPB [low permeability barriers] at mine sites, although it is known that no significant LPB flows have compromised the safe and efficient operation of open pits. . . . . It is particularly important to quantify the effects of ionic strength, SAR and major ion chemistry on the permeability of LPB during flow of several pore volumes, since there is currently no evidence, at laboratory or site scale, that LPB will remain effective with changing chemical conditions.[232]

A recent (2021) literature search yielded no papers reporting on studies of groundwater barrier degradation over time.

Even if liners and barriers last for many decades, they are likely to break down before water quality at a mine site has become benign. Theoretically liners and barriers can be repaired or replaced, but how likely is that in reality? If two hundred years from now it is discovered that an old tailings pile is leaking to the point that Birch Lake has a sulfate level of 30 mg/L and wild rice has disappeared from the lake, it is unlikely that the pile will be moved to replace the liner. Instead, it will become just one more example of the extent to which people of the 20th and 21st centuries enriched themselves at the expense of future generations.

Dams, berms, and "dry stack" tailings are additional structures that will have to maintain their integrity over the long term. These facilities along with caps and groundwater barriers will all need occasional inspections and maintenance over centuries or millennia. The potential that such

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[231] U.S. EPA (1998, Aug.). *Evaluation of subsurface engineered barriers at waste sites.*
[232] Timms, W., Liu, H., & Laurence, D. (2013). Design of low permeability barriers to limit subsurface mine water seepage. In *Water in mining 2013*. The Australasian Institute of Mining and Metallurgy.

inspection and maintenance will eventually fall by the wayside is extremely high. The need for periodic attention may be forgotten over the extended passage of time; infrequent maintenance requirements may not be adequately communicated to new staff, or may simply be unacknowledged or unassigned. The 2018 washout of the closed Hector Mine into the Embarrass River near Babbitt typifies the impacts that can result.[233,234]

Facilities that continue to operate over hundreds of years also present increased risk to the environment due simply to probabilities over time. For example, if the likelihood of a wastewater treatment plant malfunction and resulting release of polluted water to the environment is 1 per 50 years and wastewater treatment was planned to operate for 25 years, there would be a 50 percent probability of such an event during the lifetime of the project. On the other hand, if wastewater treatment is planned for a 500-year period, 10 such events could be expected.

Finally, changing geological or structural conditions may result in new or increased discharges after centuries have passed. As the EPA put it,

> releases from waste rock disposal can arise years after operations have ceased, through discharges of mine influenced water, and pile deformation or collapse. Most mines require ongoing management for acidic drainage. Evidence has shown that such problems

[233] Glanville, R. (2018, April 24). Hector mine pit wall blowout discharging to Embarrass Lake, Minnesota. [Photo].
[234] Thomas, R. (2018, May 10). Closed mine comes back to haunt the Northland. *Duluth Reader*.

> continue to be a problem even at sites that have been inactive for more than a century. Thus, discharges can take years to develop, and pose a long-term risk of hazardous releases at the site.[235]

The situation at the Flambeau Mine in Wisconsin provides an example. The backfilled pit ends about 140 feet from the Flambeau River; a slurry wall was left to separate the river from the pit. Contaminated groundwater from the pit is almost certainly moving around or through the wall into the river, as predicted in the permit application.[236] Although water seeping from the pit has a copper concentration of up to 503 ug/L and a manganese concentration of up to 31 mg/L,[237] monitoring 400 feet downstream indicates that the seepage is of low enough volume that water quality standards are not threatened beyond the mixing zone. However, we do not know the fate of the slurry wall over the more than 4,000 years that the groundwater is predicted to remain contaminated.[238] Whether a slurry wall will remain intact for the length of time that water leaving the pit will remain toxic to aquatic life is a question environmental review did not address.

j. Sulfide-ore copper mining has a terrible track record, and modern mines continue to pollute water

Data from the U.S. Environmental Protection Agency (EPA) Toxic Release Inventory show hardrock mining,[239] including copper mining, to be the nation's largest toxic polluter.[240] In 2000, the industry released 3.4 billion pounds of toxics, or 47 percent of all toxic waste released by all U.S. industries for the year. [241] Many hardrock mine sites present high or medium risk to human health.[242] The EPA estimates that hardrock mining is responsible for the contamination of streams in the headwaters of more than 40% of watersheds in the western United States.[243]

In 2004, EPA estimated the costs to clean up 156 hardrock mining sites in the U.S. to be between $7 billion and $24 billion. At the time, the federal government's maximum exposure was estimated as $15 billion, which was an order of magnitude larger than EPA's annual Superfund budget.[244] After a recent 10th Circuit Court of Appeals decision, however, the United States and

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[235] U.S. EPA, Financial responsibility requirements under CERCLA § 108(b) for classes of facilities in the hardrock mining industry, 82 Fed. Reg. 3388 (Jan. 11, 2017).
[236] Foth & Van Dyke (1989). *Prediction of groundwater quality downgradient of the reclaimed pit for the Flambeau Project.* Prepared for Flambeau Mining Co. http://digicoll.library.wisc.edu/cgi-bin/EcoNatRes/EcoNatRes-idx?type=turn&entity=EcoNatRes.MinPerApp2.p0231&id=EcoNatRes.MinPerApp2&isize=M.
[237] Flambeau Mining Co. (2018, Nov. 13). Letter from Cline, D., President, to Siebert, D., Bureau Director, Wis. Dept. of Natural Resources, re: Reclaimed Flambeau Mine request to modify the updated monitoring plan.
[238] Foth & Van Dyke (1989).
[239] The term "hardrock" generally refers to metallic minerals, and is often used to refer to mining of minerals other than coal.
[240] U.S. EPA (n.d.a). *Toxic Release Inventory*. [Online only] Retrieved January 10, 2022 from: https://www.epa.gov/toxics-release-inventory-tri-program/find-understand-and-use-tri
[241] U.S. EPA Office of Inspector General. (2004, March 31). *Nationwide Identification of Hardrock Mining Sites.* (Report No. 2004-P-00005).
[242] *Id.*
[243] U.S. EPA (2000, May). *Liquid assets: America's water resources at a turning point*. [EPA-840-B-00-001]
[244] *Id.*

its federal agencies may have increased responsibility for cleanup costs for toxic mine sites on National Forest lands.[245]

These figures and most of the discussion below refer only to pollution that violates regulatory limits. As discussed elsewhere in these comments, degradation of high-quality surface waters up to the level of water quality standards is generally allowed by mining permits, and happens at every sulfide-ore mine with any proximity to surface water. Most mines are also allowed a "compliance boundary," within which exceedances of groundwater quality standards are allowed and considered to be within regulatory limits.

1. Several studies indicate that virtually every sulfide-ore copper mine releases polluted water to the environment

A 2006 in-depth, peer-reviewed report on 26 representative U.S. hardrock mines (52% of which were still operating and 48% of which were closed) found that 76% had caused exceedances of groundwater and/or surface water quality standards. These exceedances occurred despite mitigation measures designed to prevent them. Of the mines located in close proximity to surface water and excavating rock with high potential to generate acid or leach contaminants, 92% impacted surface water, and 85% caused exceedances of standards or permit limits in surface water.[246]

Mines in the Duluth Complex would fall into this high-risk category. As explained above, Duluth Complex rock has a proven record of acid generation and contaminant release. The Withdrawal Area is located within the most freshwater-rich portion of the most freshwater-rich National Forest in the National Forest System. Potential mine sites are riddled with surface waters (wetlands, lakes, and streams) that drain by multiple flow-paths to Birch Lake and the South Kawishiwi River.[247] Most sulfide-ore copper mining in the United States and elsewhere is conducted in drier locations, such as the arid southwestern U.S. and the Atacama desert of northern Chile. Even in arid places, sulfide-ore copper mining has a record of long-lasting water pollution.

The nonprofit organization Earthworks has conducted several investigations of the track record of both sulfide-ore mines producing a range of minerals, and of sulfide-ore copper mines specifically. These investigations have found that almost all sulfide-ore mines (and particularly, sulfide-ore copper mines) operating in the United States today have polluted water. As of 2012, fourteen[248] out of a total of sixteen currently operating copper mines had been operating for at least five years. A peer-reviewed report[249] of those fourteen mines found that all (100%) had experienced pipeline spills or other accidental pollution releases. Altogether, the mines

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[245] *Chevron Mining Inc. v. USA*, 863 F.3d 1261 (10th Cir. 2017); Available at: https://cases.justia.com/federal/appellate-courts/ca10/15-2209/15-2209-2017-07-19.pdf?ts=1500481887

[246] Kuipers, J.R., Maest, A.S., MacHardy, K.A., & Lawson, G. (2006). *Comparison of predicted and actual water quality at hard rock mines: The reliability of predictions in Environmental Impact Statements.*

[247] *E.g.,* Twin Metals Minnesota (2019b), Fig. 3-22.

[248] The fourteen mines covered by the study represented 89% of U.S. copper production at that time.

[249] Gestring, B. (2012). *U.S. Copper Porphyry Mines: The track record of water quality impacts resulting from pipeline spills, tailings failures, and water collection and treatment failures*. Earthworks.

experienced a total of 154 accidental releases over an approximately 20-year period, with an average of eleven per mine.

Tailings spills occurred at more than half the sites. At four of the mines, partial tailings impoundment failures had occurred. At thirteen of the fourteen mines, water containment and collection systems failed to contain contaminated seepage, causing negative water quality impacts. At the two largest mines in New Mexico, the state and federal governments had filed charges because of severe damage to surface and ground water from 2 million gallons of contaminated seepage per year.

A 2019 Earthworks report reviews the fifteen copper mines that at that time produced 99% of U.S. copper. That report reached similar findings:

> **14 out of 15 (93%) failed to capture and control wastewater, resulting in significant water quality impacts.** These unauthorized wastewater releases occurred from a number of different sources including uncontrolled seepage from tailings impoundments, waste rock piles, open pits, or other mine facilities, or failure of water treatment facilities, pipeline failures or other accidental releases.[250]

The mine that was not reported to have significant water quality impacts is the Safford Mine in Arizona. This is a desert mine in an area with ten inches of rainfall per year. The primary environmental issue is the need for water for ore processing and dust suppression. Groundwater is pumped not to dewater the mine workings, but to provide a water supply. Mitigation measures (such as reducing the use of water for irrigation on other land in the watershed) is required to prevent impacts to the nearest perennial surface waters, which are seven miles away.[251,252,253]

For most of the mines in the 2019 report, the most recent data available was from 2015. Nonetheless, it is apparent that spills and other releases are not a thing of the past. For example:

> In 2019, the Chino Mine released 2 million gallons of tailings slurry due to a failed coupling on the pipeline that carries tailings from the concentrator to the tailings pond. The tailings flowed into a diversion of Whitewater Creek upstream from James Canyon Reservoir, and the report found that it was "likely that an unknown volume of the aqueous portion of the tailings slurry, some of the tailings solids entered the reservoir."

At the Ray Mine:

> In 2012, seepage from the tailings impoundment was released into two catch basins and into a tributary of the Gila River. At the time of the report, seepage into the tributary was estimated at 75 gpm. The incident occurred as a result of operator error during the

[250] Gestring, B. (2019). *U.S. operating copper mines: failure to capture and treat wastewater.* Earthworks.
[251] U.S. Geological Survey (n.d.a). *Freeport McMoRan-Safford Mine groundwater monitoring.* Retrieved Dec. 21, 2021 from https://wim.usgs.gov/geonarrative/freeportmcmorangwmonitor/.
[252] Freeport-McMoRan (2021). United States Securities and Exchange Commission Form 10-K FY 2020.
[253] U.S. Bureau of Land Management (2003). *Final environmental impact statement for the Dos Probes/San Juan Project*. https://azmemory.azlibrary.gov/digital/collection/feddocs1/id/1748/.

> initiation of a new upstream construction method at its Elder Gulch Tailings impoundment in 2011.

And:

> In 2015, the Robinson Mine in Nevada experienced seepage from its Tailings Storage Facility – resulting in groundwater degradation from sulfate at levels above the 500 mg/l requirement and resulting in the issuance of a Finding Of Alleged Violation and Order in April 2015. In late May 2016, a 0.8 gpm flow of tailings solution was observed emanating from a small area of bedrock in a road-cut exposure immediately downslope of the downstream face of the Eastern Embankment Extension.

Another review by Earthworks along with Montana Trout Unlimited was released in 2018 and examined all of the twelve hardrock mines that had begun operations in Montana since 1980.[254] At least eleven had resulted in exceedances of water quality standards in surface and/or groundwater; impacts of the twelfth (the Continental Pit) could not be determined because information on that mine is combined with information on the adjacent Berkeley Pit, which has been polluting area waters for years and is a designated Superfund site.

A 2020 Earthworks review of the five major operating hardrock mines in Alaska (all of which began operations between 1989 and 2005) found that all five had "experienced at least one major spill or other accidental release of hazardous materials;" four had "failed to capture or control contaminated mine water, resulting in water quality violations that often occurred over an extended period;" and four had been "identified as out of compliance with federal laws to protect clean air or water in the last 3 years."[255]

The clear message of these reports is that although the mechanism for pollution releases and impacts on water cannot be pre-determined (even with a detailed, comprehensive mine plan) the potential for such releases is high to the point of being virtually certain. Water quality impacts to surface and/or groundwater should be expected at *any* sulfide-ore copper mine.

For many years, the state of Wisconsin had a law that precluded the issuance of mining permits for the mining of sulfide-bearing ore until a permit applicant could show that at least one mine in the United States had both operated and been closed for ten years without polluting surface water or groundwater. No company was able to make this showing, and the law was finally rescinded in 2017.[256] It seems safe to conclude that no mine had met the standard as of that date.[257]

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[254] Montana Trout Unlimited & Earthworks (2018, Sept.). *Track record: Montana modern hardrock mining.*
[255] Gestring, B. (2020, March). Alaska Metal Mines: The track record of impacts to land and water from the failure to capture and treat mine pollution. Earthworks.
[256] Opoien, J. (2017, November 8). Bill to end Wisconsin's effective sulfide moratorium heads to Scott Walker's desk. *Madison Cap Times*.
[257] Kaeding, D. (2018, July 25). Counties prepare for potential mining projects as moratorium repeal takes place. *Wisconsin Public Radio*. https://www.wpr.org/counties-prepare-potential-mining-projects-moratorium-repeal-takes-effect%20 (noting that the bar was "set high enough to effectively block any new mining.")

We are unaware of a mine that has met this standard today; a careful look at the examples that have been offered by industry reveals that these mines either have in fact exceeded water quality standards, or have not operated long enough or been closed long enough to determine that they will not exceed standards.[258] Furthermore, the best-performing mines are not comparable to mines that could be developed in the Duluth Complex because they are much smaller, mine higher-grade ore, mine rock that is unlikely to produce acid, and/or are located in a desert.

2. The mines most often touted as successful have in fact polluted water, and are not comparable to potential Duluth Complex mines

None of the mines commonly offered as examples of successful sulfide-ore copper mines have both operated and been closed without polluting surrounding waters. These mines also bear no resemblance to mines that would be sited in the Rainy River-Headwaters. The Forest Service should look closely at the records of sulfide-ore copper mines purported to be non-polluting, and take into account differences between the asserted non-polluting mines and potential projects in the Duluth Complex. Such differences include ore grade; ore and waste rock constituency, including propensity to generate acid and/or to release pollutants under neutral conditions; size; climate; proximity to surface water; groundwater conditions; and whether ore is processed and tailings disposed of on site.

i. <u>The Flambeau Mine has polluted water, was very small in size, and did not process ore on site</u>

The Flambeau mine in Wisconsin is commonly cited by mining proponents as a non-polluting mine, but despite its very small size and short operational life, this mine has polluted both ground and surface water. The 38-acre mine operated from 1993 until 1997, producing a total of two million tons of ore. (In comparison, the Maturi mine plan called for mining 163 million tons over a period of 25 years.[259]) After reclamation, polluted drainage of the operations and transportation site was discovered to be discharging to Stream C, a small tributary of the Flambeau River. Copper levels in the stream exceeded the legal limit set to protect fish and other aquatic life on a consistent basis for more than 12 years; the stream is listed as an "impaired water" for copper and zinc toxicity to aquatic life.[260,261,262]

Groundwater at the site is also polluted.[263] The mining company was given a 1200-foot compliance boundary, so exceedances of water quality standards within that boundary are not permit violations. However, the compliance boundary in the direction of groundwater flow crosses the Flambeau River; all polluted water moving away from the site is assumed to discharge to the Flambeau River, with no monitoring to determine whether impacted groundwater flows under the river. Furthermore, concentrations of heavy metals in groundwater

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[258] Because pollution often begins after mining ends and the water table is restored, conclusions that a mine has not polluted cannot be made until many years after closure.
[259] Twin Metals (2919b), Table 2-11.
[260] Wis. Dept. of Natural Resources (2012). *Surface water quality assessment of the Flambeau Mine site.*
[261] Chambers, D. (2012, March 9). *Supplemental expert report of Dr. David M. Chambers*.
[262] U.S. EPA (2014, June 25). *Decision document for the approval of Wisconsin's 2012 list with respect to section 303d of the Clean Water Act,* p. 66.
[263] Moran, R.E. (2019). Flambeau Mine: Water contamination and selective "alternative facts."

at the site have been up to 45 times higher than predicted for copper and 70 times higher than predicted for manganese.[264]

In addition to being very small, the Flambeau Mine did not process ore or dispose of tailings at the site. The ore was of a high enough grade that it was economical to ship it elsewhere for processing. [265] This mine thus cannot be compared to mines in the Duluth Complex, which will require processing plants and large tailings disposal facilities nearby. These facilities usually generate the largest volumes of polluted water that must be managed and discharged at a mine site.

ii. The Eagle Mine has not yet closed, the degree of pollution is uncertain, and the mine is very small

The Eagle Mine in Michigan opened in 2014 and is still operating, making it too early to understand environmental effects or to judge it a success. Furthermore, this mine is very small, making comparisons to potential mines in the Duluth Complex inappropriate. The combined Eagle and Eagle East deposits total roughly 5 million tonnes; the areal extent of the underground resource is just six acres.

The Eagle Mine also mines high-grade ore, making it economical to ship the ore a considerable distance for processing.[266] Processing occurs at a former taconite processing plant 66 miles from the mine.[267] Tailings are disposed of underwater in a mined-out taconite pit; excess water is treated and discharged. The discharge is not benign. Initially, discharge was to wetlands and small tributaries to the Escanaba River; monitoring indicated occasional elevation of several pollutants above benchmark levels in those waters. Copper, nickel, and arsenic in sediments at discharge locations also rose to between the "threshold effects concentration" and the "probable effects concentration." Discharge has subsequently been changed to a direct discharge to the Escanaba River to take advantage of its greater dilution capacity.[268]

iii. The Stillwater Mine is still operating, and has violated water quality permit limits and water quality standards

The Stillwater Mine in Montana has resulted in high levels of nitrogen in groundwater and elevated levels in the Stillwater River. It was discovered in 2003 that the tailings facility was leaking approximately 10 gallons per minute into groundwater. In addition, a land application discharge (LAD) solution storage pond had a clay liner that did not perform as expected and

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[264] Flambeau Mining Co. (2018, Nov. 9). Letter from Cline, D., to Siebert, D., Wis. Dept. of Natural Resources, re: Reclaimed Flambeau Mine Request to Modify the Updated Monitoring Plan, Att. 1, Table 2. Note that the 1997 predictions found on this table were made at the end of mining, when monitored constituent levels were already much higher than predicted in 1989.
[265] Wis. Dept. of Natural Resources (n.d.a). *Reclaimed Flambeau Mine.* Retrieved Dec. 21, 2021, from http://dnr.wi.gov/topic/mines/flambeau.html.
[266] Like potential mines in the Rainy River-Headwaters, the Eagle Mine is located near very high-quality surface waters, making tailings disposal facilities in the immediate vicinity problematic.
[267] Eagle Mine (n.d.). *Mining 101.* Retrieved Dec. 22, 2021 from http://eaglemine.com/mining-101/.
[268] Eagle Mine (2019). *2018 Annual Mining and Reclamation Report, Humboldt Mill Mine Permit MP 01 2010.*

discharged solution to groundwater at a rate of up to 150 gallons per minute.[269] These issues have been addressed, but groundwater remains polluted.

An excerpt from the company's February 2, 2011 filing states:[270]

> Nitrogen concentrates in groundwater have been elevated above background levels at both the Stillwater Mine and the East Boulder Mine as a result of operational activities and discharges currently authorized under permit. Noncompliance with standards have occurred in some instances and are being addressed by the Company through action plans approved by the appropriate federal and state regulatory agencies. In view of its good-faith efforts to comply and progress to date in implementing remedial and advanced treatment technologies, the Company does not believe that failure to be in strict compliance will have a material adverse effect on the Company. The Company further anticipates that the implementation of remedial measures will be effective in mitigating impacts to a level that meets permit and statutory water quality standards.

But six years later, its February 16, 2017 filing reports, "in some instances, concentrations continue to exceed regulatory levels."[271]

Although the Stillwater Mine is not as small as the Eagle and Flambeau Mines, it is considerably smaller than mines in the Duluth Complex would be. The Stillwater Mine has the capacity to process 3,000 tons of ore per day, although it generally processes less.[272] (The Maturi Mine would process 20,000 tons per day.) Because the mine is still operating, impacts on area waters following closure are unknown.

3. All sulfide-ore copper mines experience the types of upsets and failures that result in discharges of polluted water

Discharges of polluted water occur when mining facilities, structures, or mitigation measures do not perform as expected. "Mitigation measures" include systems intended to keep mining-impacted water and other liquids or sludge from entering groundwater and surface water, and include containment, collection, transport, storage, and treatment facilities.

Kuipers and Maest found that failure of mitigation measures to work as intended is a common root cause of water quality impacts from mining operations.[273] The Earthworks reports cited above also indicate that every copper mine experiences spills, leaks, and/or other accidents affecting these systems. Mishaps can stem from design errors, operator errors, insufficient maintenance, unexpected storm events, unanticipated volumes of water, power outages, material

[269] Kuipers, et al. (2006).
[270] Stillwater Mining Co. (2011, Feb. 2). United States Securities and Exchange Commission Form 10-K FY 2010.
[271] Stillwater Mining Co. (2017, Feb. 16). United States Securities and Exchange Commission Form 10-K FY 2016.
[272] *Id.*
[273] Kuipers, et al (2006).

or manufactured part failures, and accidents involving wildlife. As two industry spokespeople put it in a presentation on the best-performing mines, if anything can go wrong, it will.[274]

Every incident arises from a unique set of circumstances; the specific problems that will arise at a particular mine cannot be known ahead of time, and are thus difficult to guard against. However, a few types of features and mitigation measures are used by virtually all mines and are critical to safeguarding water, including liners and caps, groundwater barriers, tailings disposal structures, pipelines, storage ponds, and water treatment plants. These systems are all affected by significant uncertainty in their design and use at specific locations, in their installation and maintenance, and in their longevity.[275]

i. Liners and caps

Most modern mines use liners under rock stockpiles, tailings disposal facilities, ponds, and/or ditches. Caps are often added to waste rock and tailings facilities during reclamation. While it is generally acknowledged that all liners leak,[276] liners and caps are assumed to perform at the level designated by their manufacturer, expressed as the amount of leakage expected to escape the liner or cap over a certain area. For a number of reasons, however, the leakage rate that will occur in the field is highly uncertain. The presumed leakage rate assumes that the liner will be installed perfectly, but conditions in the field are never perfect. Tailings facility liners in particular often cover one or more square miles; preparing the ground and spreading a liner over that large an area will always have discrepancies. Precipitation, temperature, blackflies, and wildlife can all affect conditions in the field and workers' ability and commitment to doing a perfect job.

A mining geomembrane manufacturer provides the following description of difficulties with installation:

> Even the best geomembranes and reinforced liners can tear during installation or wear punctures that develop after a few years of use. The stones in the soil may seem small or somewhat smooth, but the rough surfaces of the rock do a lot of invisible damage to the geomembrane as it's dragged over them. Improper grading and poor leveling practices also create uneven support for the liner. Trying to remove large or sharp rocks without re-grading the soil often leaves voids just below the surface. Even a small void of a few inches in depth allows the liner to bulge out, creating a stress point that can become a leak over time. . . . .
>
> Some projects achieve smooth and perfectly graded pond forms only to watch the liner dip and tear as voids form below the surface. Adding the high weight of the water or waste material to the liner quickly shifts loose or wet soils that aren't ready to bear the stress. Collapses that occur around banks can release the wastewater or other contained

[274] Eger, P., & Ongaro, F. (2014). *Successful Non-Ferrous Mining: Promise or reality?* [PowerPoint presentation].
[275] The uncertain longevity of many of these systems is addressed in Part 2, Section A.II.i.3. above.
[276] Rowe, R.K. & Sangam, H.P. (2002). Durability of HDPE geomembranes. *Geotextiles and Geomembranes, 20,* 77-95.

> material to create an environmental or health hazard. Even small collapses under the middle of the pond structure pose the problem of creating new leaks. . . . .
>
> The sheer size and high-volume requirements of the mining industry make it hard to plan and build leak-proof ponds. It's hard to keep track of every inch of liner-covered base and bank, especially when dealing with multiple ponds covering dozens of acres altogether. Spreading the liner over so much area reduces the amount of attention paid to any one spot that might be damaged or have a weak seam. . . . .
>
> The combinations of corrosive chemicals and abrasive minerals commonly found in mining ponds and basins are tough on the liners used to contain them. Even the best materials . . . face higher wear and tear when used in the mining industry. . . . .
>
> Between the weight of the water, mixed in waste products, and any deposited sediment or ore, the liners in mining ponds are constantly under a heavy weight load. This leads to tearing, splitting, stretching, and increased seepage as tiny pores open up in the surface. . . . .
>
> With the sheer size of most mining ponds calling for liners that weigh hundreds to thousands of pounds, heavy equipment is often required for some or all of the installation process. Yet the very use of this equipment to carry and spread out the material also increases the chances of damage before the pond is ever filled. . . . . Even foot traffic can create punctures when the material is stretched against a rock or void by the person's weight.[277]

These construction and management issues continue to affect the most recently permitted mines. According to a recent article from Finland,

> While basal structures of tailings ponds have been improved, problems relating to harmful seepage waters have not been entirely solved. In recent years, leakages have occurred even through geomembrane-lined basal structures meeting the new requirements for mining operations. For example, at the Talvivaara mine in Finland, which was opened in 2008, leakages were detected in 2008, 2010, 2012, and 2013, at the Kittilä mine in Finland, also opened in 2008, leakage was reported in 2015, and at Kikoya Gold Mine, Liberia, opened in 2014, the latest liner failure was reported in 2017.[278]

The Tuomela paper also describes the results of a study of liner performance and quality assurance methods reported on at an industry conference in Scotland:

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[277] BTL Liners (n.d.) *Installation challenges for mining geomembranes*. Retrieved Nov. 11, 2021, from https://www.btlliners.com/installation-challenges-for-mining-geomembranes.

[278] Tuomela, A., Ronkanen, A.-K., Rossi, P.M., Rauhala, A., Haapasalo, H., & Kujala, K. (2021). Using geomembrane liners to reduce seepage through the base of tailings ponds—A review and a framework for design guidelines. *Geosciences*, *11*, 93. https://doi.org/ 10.3390/geosciences11020093.

> According to Garrick et al.,[279] the performance of HDPE liners is extremely sensitive to defect occurrence rates, and is thus highly dependent on liner manufacturing and construction quality. Their calculations indicated that a single HDPE liner requires construction to the highest CQA standards to be of significant benefit in reducing the seepage rates of a tailings pond and that, even when the CQA standard is "good", the liner can have higher hydraulic conductivity (>1 × 10^{-8} m/s) than the tailings on top of it.

Tuomela et al. point out that in the last two decades, regulators have made assumptions about the efficacy of liners in mining applications based on their use at landfill sites, but that "few case studies describing geomembrane-lined tailings ponds have been performed worldwide. Previous studies present basic examples and design criteria for well-functioning basal liners, but practice has proven to be more complex. . . . . Good practices, design criteria and user experience are lacking."

ii. <u>Groundwater containment and collection systems</u>

For most proposed mines, it becomes clear during mine planning and environmental review that some aspect of the operation will require a groundwater containment and/or collection system. For the NorthMet mine, regulatory agencies required groundwater barrier systems to contain leachate from an unlined waste rock stockpile and from the tailings basin. For the Maturi mine, the company proposed a grout curtain to circle the tailings disposal facility and unlined ditches.

The effectiveness of groundwater barrier systems is difficult to assess and subject to much uncertainty, especially in mining applications. The most commonly cited (and as far as we have been able to determine, the only available) study is an EPA report from 1998 reviewing 36 applications in the clean-up of hazardous waste sites.[280] The report includes several caveats. It points out that "[t]he subsurface nature of barriers makes monitoring . . . difficult and performance measurement . . . ambiguous" and notes the likelihood that some releases had not been detected by monitoring. One hundred thirty sites were identified, but only 36 were assessed. "The other sites were eliminated from the study because of the lack of availability of design, construction, or monitoring data. (It is likely that some sites that were eliminated do not perform as expected.)" Furthermore, 25% of the selected sites did not have acceptable monitoring data. The sites were not identified by name in the report, because "some site owners required anonymity before they would release data." Therefore, the information in the report cannot be verified.

The review assessed whether each barrier had met the goals for its particular application, rather than the performance of barriers in absolute terms (such as a percent reduction in groundwater flow). Furthermore, for most sites the EPA was unable to determine with certainty whether the goals had been met. Of the 36 sites, the EPA determined that 8 had met their goals and that it

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[279] Garrick, H., Digges La Touche, G., Plimmer, B., & Hybert, D. (2014). Assessing the hydraulic performance of tailings management facilities. In Hunger, E., Brown, T.J. & Lucas, G. (Eds.). *Proceedings of the 17th Extractive Industry Geology Conference*, pp. 125-134. https://static1.squarespace.com/static/54199a46e4b05afa19b4e68c/t/545770b9e4b05903c3d20109/1415016633320/16+Garrick.pdf.

[280] U.S. EPA (1998, Aug.).

was more likely than not that an additional 17 had met their goals. It was likely that 7 had not met their goals, and 6 had insufficient evidence for even this level of determination.

This study provides no information on the actual extent to which these systems are able to reduce groundwater flow. Furthermore, the experience of their use at hazardous waste sites is not directly applicable to mining. One significant difference is the size of mine sites in comparison to typical hazardous waste sites. At both the NorthMet and Maturi projects, the underground barriers would stretch for miles. The same will be true for any mine built in the Duluth Complex, as the scale of the operation has to be very large to make mining low-grade ore economical. As the length of these barriers increases, the potential for imperfections and faulty installation increases as well.

As a cooperating agency for the NorthMet EIS, the Fond du Lac Band of Lake Superior Chippewa attempted to find examples of groundwater barrier systems with data reflecting on their efficacy. The following is from the Band's comments:[281]

> A search for examples similar to the Project Proposed Action identified the Zortman-Landusky mine in Montana, which installed containment and pumpback systems to be used in conjunction with a wastewater treatment facility. However, they "did not capture all surface and subsurface drainage." At the Molycorp, Inc., mine site in New Mexico, "The pathway for contaminant migration is the leaching of tailing seepage downward from the tailing facility to ground water that migrates through fractures to surface water."
>
> Examples of similar seepage capture systems installed and operating in northeastern Minnesota are at the US Steel-MINNTAC tailings basin, and the former LTV tailings basin seep SD0026 (the same tailings basin PolyMet proposes to re-use), and demonstrate capture rates of less than 60%. . . . .
>
> It is important to note that seepage capture of greater than 95% would be required at MINNTAC in order to achieve compliance with applicable water quality standards. However, at this facility, this high capture efficiency was concluded to be infeasible, and MINNTAC predicted that their capture efficiencies would not exceed 60%; actual performance of the capture system is below 50%. . . . .

As discussed in Part 2, Section A.II.e. above, effective installation of these systems is highly dependent on a detailed understanding of site geology and hydrogeology, something that is not required for mine plans in Minnesota. In a geological setting such as the Duluth Complex area, where both bedrock fractures and bouldery till are common, effective installation may be impossible. The U.S. EPA review notes that among the 36 sites it reviewed, even "sites that have exemplary design, CQA/CQC, and monitoring systems" experienced releases.

[281] Schuldt, N. (2014). Letter to Fay, L., MDNR, Bruner, D., U.S. Army Corps of Engineers, and Jiminez, M., Superior National Forest. (Citations omitted.)

iii. Tailings disposal facility failures

The EPA estimates that about 50% of contaminant releases at modern mines involve tailings.[282] In addition to pipeline and other spills in transport, these releases may be due to dams, liners, and other containment features that leak more leachate to groundwater than expected; from small dam breaches or overtopping, often due to insufficient maintenance or large storm events; or from catastrophic dam failures. Drystack facilities leave huge piles of fine material, which in Minnesota's climate are likely to be subject to re-saturation, slumping, erosion, or transport as fugitive dust.

Tailings facility failures occur despite the best engineering industry has to offer. Human error at some point in the long life of a tailings facility (engineering, construction, inspection, operation, and maintenance extending for centuries) almost always plays a part. These failures happen often enough that they should be considered a potential occurrence at any mine.

The large dams built to contain mine processing waste (a.k.a. "tailings dams") are among the largest dams and structures in the world. Much of what they are built to hold back is toxic.[283] The dams must stand, unfailing, in perpetuity. They must be forever monitored and maintained, as the waste never goes away.[284] Tailings dams present serious hazards that can and do result in catastrophic failures.

Although the first submitted mine plan for the Rainy River-Headwaters watershed proposed a drystack tailings disposal facility, future mine plans could well include proposals of tailings basins held back by dams, given the significant pollution risks and incompatibility with Minnesota's climate that MDNR has identified with drystack tailings piles.[285] Tailings basins would likely be permitted by MDNR even in the headwaters of the BWCAW, as MDNR takes the position that it does not have the authority to disapprove this type of facility if the permit applicant's plan otherwise meets the requirements of the rules.[286]

Rather than improving over time, as the mining industry claims, the pace of tailings dam failures over the last 50 years has remained fairly constant: about one tailings dam fails every eight months, which equates to three failures every two years.[287] Records show that most tailings dam failures occur at operating mines, many of them in the United States. In short, tailings dam failures occur at modern mines and in countries with supposedly strong mine safety regulations.

Larger mines with lower-grade deposits lead to larger tailings facilities and larger dams. The areas targeted for mining in the Withdrawal Area have a combined copper-nickel concentration of less than 1%, meaning that more than 99% of any ore that might be mined would be left in the

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282 U.S. EPA, Financial Responsibility Requirements Under CERCLA § 108(b) for Classes of Facilities in the Hardrock Mining Industry, 82 Fed. Reg. 3388 (Jan. 11, 2017).
283 Paperny, A.M. (2014, Aug 5). What's in Imperial Metals' Mount Polley tailings? Should you be worried? (Updated Sept. 9, 2014). *Global News*.
284 Chambers, D.M., & Higman, B. (2011, Oct.). *Long Term Risks of Tailings Dam Failure*.
285 MDNR (2018, Nov. 1). *NorthMet Project Dam Safety Permits, Findings of Fact, Conclusions, and Order of Commissioner*.
286 *Id.*
287 Chambers, D.M. & Higman, B. (2011, Oct.).

form of waste tailings.[288] The trend toward larger mines with lower ore grades means that tailings mixed with contaminated water is being left behind ever-larger tailings dams, creating greater risks and more catastrophic consequences of failure. [289]

Reflecting this trend, the frequency of "serious" and "very serious" tailings dam failures has increased in recent decades. Sixty-four percent of the 52 recorded failures between 1990 and 2010 were in the serious or very serious category.[290] The number of serious tailings storage facility failures is projected to rise. Robertson (2011) describes a level of risk that grows by a factor of twenty every one-third century.[291]

According to World Mine Tailings Failures.org, an organization dedicated to studying this issue and pushing industry and governments to address it on a global level, "We can expect the magnitude of the predicted 18 failures 2015-2024 to be far greater than even the worst of what we have already experienced." The organization's website provides a table of known dam failures by decade since 1950, and concludes, "The increasing frequency and severity of significant failures is apparent. Release, runout and deaths are all dramatically higher 2010-2019 than 2000-2009."[292]

In addition to catastrophic impacts when a dam fails, it is not possible to recover the pollution released into the landscape by such a failure. To the extent that remediation is possible, it is very expensive; in one review of seven incidents, the average cost per failure was $543 million.[293] As the number of serious mine failures rises, the average cost to mitigate the addressable effects will also rise. Most mining companies are not able to cover losses this large, and no loss remediation pool or risk management program exists to spread the cost of serial catastrophes. Losses may not be covered by insurance if they are caused by failure to follow accepted practices; costs in such cases would fall to the public or the damage would go unremediated.

While stockpiling tailings on relatively dry land (misleadingly referred to as "drystacking") may reduce the degree of catastrophic risk compared with storing them in a slurry behind dams, it can increase the risk of acid generation and does not eliminate the potential for leachate to impact surrounding waters. Furthermore, a degree of catastrophic risk remains. MDNR states:

> In a wet climate, dry stacking has major environmental disadvantages. Maintaining dry stacked tailings as "dry" in areas with substantial precipitation and/or a high water-table is difficult. Once exposed to rain or snow, the dry stack becomes wet, so most of the benefits of dry stacking are lost. Dry stacked tailings that become wet again (but are not

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[288] *See* Duluth Metals (2014, Oct.), Table 1-4, p. 1-16.

[289] Robertson, A.M. (2011). *Mine waste management in the 21st century: Challenges & solutions beyond incremental changes*. [PowerPoint presentation].

[290] Bowker, L.N., & Chambers, D.M. (2015). The risk, public liability, and economics of tailings storage facility failures. *ResearchGate.* https://www.researchgate.net/publication/283321865_The_Risk_Public_Liability_Economics_of_Tailings_Facility_Failures.

[291] Robertson, A.M. (2011).

[292] World Mine Tailings Failures.org (n.d.). *World mine tailings failures from 1915*. Retrieved Nov. 7, 2021 from https://worldminetailingsfailures.org/.

[293] Bowker, L.N., & Chambers, D.M. (2015).

> submerged) are subject to oxidization and leaching of heavy metals. As precipitation then intermittently washes through the tailings, those heavy metals and other constituents may be washed into surrounding soils and nearby water bodies. Seepage water will also flow into the underlying groundwater, potentially contaminating local water supplies. . . . . A perimeter dam may be required to prevent the movement of contaminated sediments and waters off-site. Construction of a perimeter dam reintroduces issues associated with maintenance of a dam for long-term storage of tailings, including the possibility of dam failure.[294]

Drystack facilities can be subject to slumping, wherein inundation due to a large precipitation event results in movement of the tailings slope. At the Maturi site, the proposed tailings facility would be close to Birch Lake and even closer to Keeley Creek and to the proposed channelized water diversion, both flowing to Birch Lake. Slumping at this site would inevitably discharge tailings and leachate to Birch Lake and downstream waters.

Finally, drystack facilities produce large volumes of fugitive dust. The facility that was proposed for the Maturi Mine would have been upwind and close enough to the BWCAW to affect air quality and the deposition of pollutants in the wilderness. This issue is addressed in Part 2, Section B, below.

iv. Pipeline failures

Virtually every modern mine uses pipelines to transport polluted water, tailings, process reagents, and/or other substances that will negatively impact the environment if spilled. And virtually all mines experience pipeline leaks, ruptures, or other failures at some point during the life of the mine. The 2012 Earthworks report cited above on 14 copper mines representing 89% of U.S. copper production found that all 14 had experienced pipeline spills of one kind or another.[295]

Minnesota taconite mines have also experienced pipeline ruptures. In 2000, a break in a Northshore Mining pipeline spilled 14,000 tons of tailings, much of it into the Beaver River.[296] In May 2013, an ArcelorMittal pipeline coupling failure released 87,800 cubic feet of mine tailings into wetlands; in a separate incident two months later, a pipeline hole released 46,000 cubic feet of tailings into wetlands.[297] A total of 3.56 acres of wetlands were filled with tailings. According to an MPCA press release, "the company had inadequately inspected and maintained the pipeline [and] pipeline ditch, . . . and had failed to report . . . releases in a timely manner."[298]

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294 MDNR (2018, Nov. 1).
295 Gestring, B. (2012).
296 Duluth Bugeteer. (2002, August 23). Tailings spill into Beaver River. *Lake County News-Chronicle.* https://www.duluthnewstribune.com/news/2004710-around-twin-ports.
297 U.S. EPA (2015, Jan. 22). *In the Matter of: ArcelorMittal Minorca Mine Inc., Virginia*. Docket No: CWA-05-2015-0010, Consent Agreement and Final Order. https://yosemite.epa.gov/oa/rhc/epaadmin.nsf/Filings/1C0FEFB6882DFEE085257E0D001BBFF3/$File/CWA-05-2015-0010%20FINAL%20CAFO%203-18-2015.PDF.
298 MPCA (2015, June). Pipeline, storage basin failures send ore tailings and road aggregate into wetlands; 2 enforcement actions result. [Press release]. https://content.govdelivery.com/accounts/MNPCA/bulletins/108f692.

As with other types of accidents, the timing and mode of failure for pipeline spills is impossible to predict. The 2019 Earthworks report reveals a number of failure mechanisms that are most notable for their diversity.[299] At the Morenci mine, a release occurred after "the process solution pipeline was connected to the stormwater pipeline." Several mines experienced flange separations or other coupling failures. At Ray, the coupling failure was due to angular deflection after a support structure failed. At Silver Bell, a welded pipeline seam ruptured; at Morenci, a pipeline was ruptured in a backhoe accident. At Tyrone, a rupture was blamed on cold weather, and at Continental Pit, on ice.

Despite this extensive history, regulators and environmental assessments often assume that significant spills will not occur. It is more realistic to assume that spills will occur, and to assess them based on the frequency and severity of past spills. The risk assessment conducted by U.S. EPA for proposed mining in the Bristol Bay watershed assesses the risk of potential pipeline spills for potential mines in that location.[300] Using the likely length of pipelines under several potential scenarios, the assessment calculated an 11% probability of one failure per year per pipeline, and a 95% probability of failure for each pipeline over a 25-year period. In each of the three scenarios studied, the assessment found a greater than 99.9% chance that at least one pipeline would fail during the project lifetime. While these numbers are of course dependent on the length of pipeline planned for a particular mine, they illustrate the fact that pipeline spills happen regularly and should be expected at any mine.

v. Ponds, tanks, and ditches

Many unplanned and unpredicted releases of mining-impacted water originate in ponds, tanks, and ditches. Again, it is impossible to predict the events that will result in releases from these facilities, and yet they occur at the majority of mines. As with other failure modes, regulators generally assume during environmental review that the ponds and ditches will hold water as expected rather than making the more reasonable assumption that releases are likely to occur at some point for an unforeseen reason.

Many of these releases have an underlying cause that is discussed elsewhere in these comments. A pond or ditch may not be large enough due to failure to adequately characterize hydrogeology, or may not be large enough to accommodate a larger-than-anticipated storm event. Leakage through liners is also a common cause of releases from ponds.

Contaminated water is also released from ponds and ditches through failure modes that may not be as obvious. At a number of mines, releases from ponds and ditches have resulted from pump failures, failures of water level indicators, and blocked drain or outlet lines. Some releases result from poor construction or design, and others from inadequate maintenance. At several mines, power outages have caused equipment shut-downs that led to pond overflows. The Earthworks reports provide examples from Bingham Canyon, Chino, Bagdad, Sierrita, Pinto Valley, Mission Complex, Robinson, Miami, Silver Bell, and Mineral Park mines.

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[299] Gestring, B. (2019).
[300] U.S. EPA (2014, Jan). *An assessment of potential mining impacts on salmon ecosystems of Bristol Bay, Alaska: Vol. 1.*

vi. Wastewater treatment upsets and failures

Wastewater treatment is increasingly required for new mining operations, and is a vast improvement over discharging mining-impacted water directly to the environment. However, treatment is not a panacea, for several reasons. Most obviously, the company can only treat water that is collected; most mines fail to entirely prevent untreated discharges to the environment even when they are designed to do so and even when they operate state-of-the-art treatment plants.

Even for the water that is collected and treated, wastewater treatment systems do not eliminate water quality impacts. Permits for wastewater discharges typically allow degradation of water quality. Discharges are usually required only to meet water quality standards, often with an allowance for a mixing zone in the receiving water. If the receiving water is of high quality, the level of some constituents will almost certainly increase due to wastewater treatment plant discharge.

In mining scenarios, and particularly in northeastern Minnesota, this commonly means an increase in sulfate. The lowest sulfate level that would likely be required for wastewater discharges under MPCA's permitting regime is 10 mg/L; as explained elsewhere in these comments, this standard is insufficient to protect wildlife and humans from increased methylmercury in fish. Cobalt is another element that may contribute to increased mercury methylation;[301] cobalt would be allowed to increase in surface waters pursuant to the NorthMet permits,[302] and one would expect a similar outcome for mines in the Rainy River-Headwaters.

Furthermore, it is often assumed in environmental review and permitting that wastewater treatment will achieve a level of performance that is speculative at best. This happened at the Eagle Mine, where operational changes and improvements proved necessary that in turn reduced treatment capacity from 900 GPM to between 400 and 550 GPM.[303] Because an average treatment rate of 600 GPM is necessary at that operation to prevent overfilling of the tailings basin, the basin rose above the maximum permitted level.

The Eagle Mine mines a high-grade ore and had the necessary financial cushion to address this issue. It added a temporary additional reverse osmosis unit while planning and installing an additional ultrafiltration unit, permanent reverse osmosis unit, and clarifier. As explained elsewhere in these comments, mines in the Duluth Complex will mine low-grade ore and are likely to be less profitable. There is no guarantee that the kind of money needed for the Eagle Mine upgrades would be available in similar circumstances at a Duluth Complex mine. These mines would also be many times larger and would need to manage a correspondingly larger amount of water.

Dr. David Chambers, the professional geophysicist and mining engineer mentioned above, has extensive experience reviewing mine plans and operations. He points out that while meeting

[301] Ekstrom, E.B., & Morel, F.M. (2008). Cobalt limitation of growth and mercury methylation in sulfate-reducing bacteria. *Environmental Science & Technology, 42,* 93-99.
[302] NorthMet FEIS 5-91.
[303] Eagle Mine (2019).

water quality standards may be theoretically possible, it is often beyond the economics of a particular project:

> Theoretically . . . water treatment methods . . . can treat mine effluent to discharge levels that meet or exceed state and federal water quality standards. However, treatment effectiveness varies by site, and cleaning mine effluent to water quality standards can become very expensive. Treatment cost is most often the limitation on treatment effectiveness.[304]

Reverse osmosis treatment systems are currently considered state-of-the-art and have been required for several recently permitted mines. Although this is not new technology, to our knowledge the scale at which treatment will be required for mines in the Duluth Complex has not yet been attempted for reverse osmosis systems.[305] These systems have a number of issues that have been glossed over in environmental review and permitting, with implications for both efficacy and cost. These issues will be exacerbated by the size of the systems, with a strong potential that the ultimate cost will be significantly more than assumed in setting financial assurance requirements.

As the U.S. EPA stated in its risk assessment for mining in the Bristol Bay watershed,[306]

> Studies of wastewater treatment plant (WWTP) efficiency and design considerations show that reverse osmosis water treatment systems can be compromised by fouling and scaling from calcium, iron, barium, strontium, silica, microbial growth, and silt (Mortazavi 2008). The Bingham Canyon WWTP in Utah treats groundwater contaminated with sulphate and total dissolved solids from copper mining by reverse osmosis. Pilot tests and optimization studies have shown that the structural integrity of its reverse osmosis membranes can be damaged by abrasive materials (e.g., silt) or chlorine (ITRC 2010). Changes in water composition could increase the concentration of chlorine if the mine pit encounters a large flow of brine transmitted to the pit through deep fracture systems, or from localized areas of mineralized rock with anomalous water quality. An example of WWTP failure due to highly variable chemical composition of inflow wastewater has been documented at a copper mine in Chile: when silica concentrations exceeded the design range, the whole reverse osmosis system could not be operated and was therefore shut down until feed water quality improved (Shao et al. 2009).

Chambers discussed reverse osmosis in his 2014 review of mining technology:[307]

> A number of separation processes utilizing membranes have been developed and are typically used for the removal of dissolved salts from water. All membrane processes

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[304] Chambers, D.M. (2014). *The potential for acid mine drainage and other water quality problems at modern copper mines using state-of-the-art prevention, treatment, and mitigation methods*. Center for Science in Public Participation.
[305] Miller, G. (2014, March 11). Letter to Fay, L., MDNR.
[306] U.S. EPA (2014, Jan.).
[307] Chambers, D.M. (2014).

> separate the feed stream into a permeate (the desalinated water that passes through the membrane) and a concentrate (the stream in which the salts are concentrated).
>
> . . . . .
>
> Membrane systems are susceptible to fouling by particulates, gas bubbles and other fouling contaminants and therefore the feed must be pretreated. . . . . Pre-treatment systems can be expensive and may account for as much as half of the desalination cost depending on the extent of pre-treatment required.
>
> Another drawback to using membranes for wastewater treatment is the production of highly concentrated brine that must be treated prior to final disposal. The brine is often evaporated using a distillation and crystallization process or evaporation ponds (only practical in arid locations). Safe disposal of the dry salts can also be problematic and requires specially constructed disposal facilities.
>
> . . . . .
>
> Reverse osmosis is expensive because the semi-permeable membranes tend to plug up or wear out, each membrane can only process a small amount of water, and the concentrated waste must be collected and managed. Typically, the waste product stream is about 15 percent of the total volume treated. If the water is highly acidic the pH must still be adjusted before the water can be released.

In addition to the difficulties inherent in day-to-day operation of a reverse osmosis system, as is true of other mitigation measures treatment plants experience upsets, breakdowns, and maintenance failures and other operator errors. The risk of such occurrences must be considered over the long and uncertain operating time that may be required. Many if not most of these plants will need to operate for hundreds or thousands of years. It is inevitable that over that span of time, any plant will experience one or more of these events. The impacts of such events are rarely discussed in environmental review, and almost never considered in the decision on whether a particular project should be permitted.

vii. Backfill

Most modern mine plans include backfilling waste rock and/or tailings into the mine workings, whether open pit or underground. Generally speaking, backfilling is a mitigation measure intended to reduce the footprint of the mine site after closure, but it is also sometimes described as a means to reduce acid production in waste rock, tailings, and mine walls, and to reduce the flow of contaminated water from mine workings.

We are submitting comments by environmental geochemist Dr. Kendra Zamzow prepared for scoping of the EIS for the Maturi project, addressing issues related to backfill.[308] Zamzow notes that paste backfill often does not provide chemical stability in an underground mine as intended.

[308] Zamzow, K. (2020, May 30). Memorandum to Matt Norton, Northeastern Minnesotans for Wilderness, re: Twin Metals Minnestoa, DEIS scoping period. Center for Science in Public Participation.

In addition to the inherent uncertainty of mine water chemistry and its interaction with backfill, Zamzow notes that the backfilling process involves uncertainties:

> Paste may be backfilled over waste rock that has been oxidizing in tunnels, may have voids between tunnel walls and paste that allow for surface oxidation, may experience oxidation at the face of each new paste layer, and in other ways may lead to release of contaminants into tunnels during operations, which could flush out as tunnels flood at closure.

Zamzow also points out that changes in pH over time and/or in the movement of geological materials from one environment to another can have unanticipated results: "Waste rock at the Eskay Creek mine in Canada went acid, and when submerged in tunnels and covered with concrete backfill, went alkaline and released antimony (MEND 2006)."[309]

Zamzow provides the following list of factors that can influence the effect of backfill on water quality:

- Potential for sulfate attack on cement (e.g. at the face of backfill or along voids between backfill and tunnel walls).
- Potential for alkaline leachate to mobilize metalloids (Sb, As, etc.).
- Length of time that leachate may be alkaline.
- Potential for gypsum formation to cause cracking in paste tails, opening up areas for potential oxidation.
- Changes in leachate chemistry with different binders, including potential to release sulfate.
- Potential for bedrock groundwater flow to preferentially move through paste tailings if the permeability is higher than surrounding bedrock.
- Potential pathways for groundwater to reach surface water.
- Potential need to treat groundwater for some period of time after tunnels flood until groundwater chemistry stabilizes.

If conditions do become acidic, flooding the backfilled mine with water will not instantaneously stop acid generation or contaminant leaching as is sometimes expected; submerged pre-oxidized tailings have been demonstrated to continue to release contaminants.[310]

viii. <u>The role of human error</u>

Human error of some kind almost always contributes to the causes for pollution from a mining operation. The error may be in predictions of the quality of leachate from various mine features, in the characterization of hydrogeology of a site, in design of mining and mitigation facilities and

[309] Mehling Environmental Management (2006). *Paste backfill geochemistry – environmental effects of leaching and weathering*. [Report 10.2.] MEND.
[310] Maest, A. (2019, June 24). *Pebble Project mine water quality predictions and implications for environmental risk: Comments on the Pebble Project Draft Environmental Impact Statement***.** (Citing MEND (2000). Flooding of re-oxidized mine tailings: Mattabi Case Study. MEND Report 2.15.1a.)

measures, in construction or installation of those facilities and measures, in operation, or in monitoring and maintenance.

Errors in design or construction of systems can ultimately result in dam breaches such as the one at Mt. Polley or liner failure such as occurred at Zortman Landusky. Mistakes may be made in operation, such as the connection of a process solution pipeline to a stormwater pipeline at Morenci or a mistake in determining water content in tailings when deposited in a drystack facility. Human error often comes in the form of accidents, such as the backhoe incident that broke a pipeline at Morenci.

Failure to conduct routine inspections and maintenance or to act on what is found are common forms of human error. When permitting mines, regulators assume that future technicians and staff will be in place, well-trained, motivated, and competent to perform maintenance and repairs and to operate equipment and systems correctly. Unfortunately, this is sometimes not the case, as indicated by the pipeline spills at ArcelorMittal.[311]

Human error most often combines with other causes that together result in a release of polluted water or other failure. Commonly, releases involve some combination of equipment problems and human error, often triggered or exacerbated by bad weather or other adverse conditions. *All* mines – indeed, all human endeavors of the size of modern mining operations – are affected by human error. And mining operations, due to their large-scale devastation of the landscape and the volumes of very polluted water they must manage, are uniquely situated to contaminate the environment when errors occur.

Ironically, U.S. mine regulators ignore the potential impacts of human error to a degree that is uncommon for other industries. Agencies that routinely use risk assessments recognize that human error must be accounted for when assessing risk. For example, the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration states, "It is important for risk models to include modeling of incorrect operations, which includes human interactions and human performance, that are significant to the likelihood of failure or have a significant effect on consequences of a failure (e.g., inappropriate controller restart of pumps, realistic emergency response time scenarios, design and construction human errors)."[312]

It has been noted that while the safety and reliability of engineered systems in-and-of-themselves continue to improve over time, the propensity for human error does not.[313] Across numerous industries, the percentage of accidents and other problems caused by human error is estimated at about 80 percent.[314] Thus despite the technological advances that have been made in aviation,

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[311] MPCA (2015, June).
[312] Pipeline and Hazardous Materials Safety Administration (2020). *Pipeline risk modeling: Overview of methods and tools for improved implementation.* U.S. Dept. of Transportation.
[313] Independent Expert Engineering Investigation and Review Panel. (2015). *Report on Mount Polley Tailings Storage Facility Breach.* Province of British Colombia.
[314] Koen, S.L. (2015, Oct. 25). Safety leadership: Neuroscience and human error reduction. *Safety + Health Magazine*. National Safety Council. https://www.safetyandhealthmagazine.com/articles/13159-safety-leadership-neuroscience-and-human-error-reduction

maritime shipping, medicine, IT, and many other industries, accident and failure rates decrease far more slowly than would be expected given improvements in technology.[315,316]

In a study of "operation events" that represented some sort of operations failure at nuclear power plants, the U.S. Nuclear Regulatory Commission made the following observations:[317]

1. Human error contributed significantly to risk in nearly all events analyzed. . . . . The average human error contribution to the change in risk was 62 percent.
2. Latent errors were present in every event analyzed and were more predominant than active errors by a ratio of 4 to 1. Latent errors were noted in all facets of performance studied, including operations, design and design change work practices, maintenance practices and maintenance work controls, procedures and procedure development, corrective action program, and management supervision. . . . .
3. Without exception, the operating events analyzed included multiple contributing factors. On the average, the thirty-seven events contained four or more human errors in combination with hardware failures. Fifty percent of events contained five or more errors. Many events contained between six and eight human errors.
4. Human errors can result in the failure or increased likelihood of failure of risk-significant equipment. For a sample of ten events with the highest event importance, human error was determined to contribute to component failure. . . . .
5. Design and design change work practice errors were present in 81 percent of events, maintenance practices and maintenance work control errors were present in 76 percent of events, and operations errors were present in 54 percent of events. . . . .
6. Forty-one percent of the analyzed events demonstrated evidence of failure to monitor, observe, or otherwise respond to negative trends, industry notices, or design problems.

These findings are mirrored in the recommendations of the Independent Expert Engineering Investigation and Review Panel on the Mt. Polley Tailings Storage Facility Breach in British Columbia. While the focus of the report was on dam design and construction and the underlying geology, the Independent Panel turned its attention squarely toward human error in its recommendations:

> Tailings dams are complex systems that have evolved over the years. They are also unforgiving systems, in terms of the number of things that have to go right. Their reliability is contingent on consistently flawless execution in planning, in subsurface investigation, in analysis and design, in construction quality, in operational diligence, in monitoring, in regulatory actions, and in risk management at every level. All of these activities are subject to human error.

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[315] Shappell, S., Detwiler, C. Holcob, K., Hackworth, C. Boquet, A., Wiegmann, D. (2006). *Human error and commercial aviation accidents: A comprehensive, fine-grained analysis using HFACS*. Federal Aviation Administration, U.S. Dept. of Transportation.
[316] Baker, C.B., & Seah, A.K. (2004). Maritime accidents and human performance: The statistical trail. In *MARTECH Conference, Singapore, Sept. 22-24, 2004* (pp. 225-239).
[317] U.S. Nuclear Reg. Comm. (2001). *Review of Findings for Human Performance Contribution to Risk in Operating Events.*

> Human error is often, if not always, found to play a key role in technological failures. And human error will always be with us, as much as we might wish it to be otherwise. This is why failures invariably bring about improvements in technology that help compensate for human error. In perhaps the most notorious containment failure, double-hulled tankers were mandated after the Exxon Valdez oil spill. Similarly, improvements to rail tank cars are being adopted in the wake of the Lac-Mégantic tragedy. But tailings dams have no such redundancies. Without exception, dam breaches produce tailings releases. This is why best practices can only go so far in improving the safety of tailings technology that has not fundamentally changed in the past hundred years.[318]

And as the EPA points out regarding pipelines in its risk assessment for Bristol Bay,

> It may be argued that engineering can reduce pipeline failures rates below historical levels, but improved engineering has little effect on the rate of human errors. Many pipeline failures, such as the cyanide water spill at the Fort Knox mine (Fairbanks, Alaska) that resulted from a bulldozer ripper blade hitting the pipeline (ADEC 2012), are due to human errors. Perhaps more important, human error can negate safety systems. For example, on July 25 and 26, 2010, crude oil spilled into the Kalamazoo River, Michigan, from a pipeline operated by Enbridge Energy. A series of in-line inspections had showed multiple corrosion and crack-like anomalies at the river crossing, but no field inspection was performed (Barrett 2012). When the pipeline failed, more than 3 million L (20,000 barrels) of oil spilled over 2 days as operators repeatedly overrode the shut-down system and restarted the line (Barrett 2012).[319]

Clearly, as long as engineered systems are dependent on human design, operation, and maintenance, theoretically perfect engineering will not eliminate releases of pollutants to the environment.

k. Mining and environmental protection methods have not advanced enough to result in mines that do not impact water

Mining proponents argue that the history of pollution from sulfide-ore copper mining does not reflect on the likelihood that a proposed "modern" mine will impact ground and surface water. Supposedly, technological advances have fixed all the myriad ways that polluted water escapes into surrounding groundwater and surface water at sites that are many square miles in size.

In reality, new methods have improved some aspects of mining operations, but most of the methods that are being used in newly permitted mines are not significantly different than the methods that have resulted in polluted water in the past.[320] Reviews of the causes of releases and state-of-the-art techniques to prevent them conclude that here are no mining or pollution control methods or mitigation technologies in existence or on the horizon that could eliminate the risks

[318] Independent Expert Engineering Investigation and Review Panel (2015).
[319] U.S. EPA (2014, Jan.).
[320] U.S. EPA, Financial Responsibility Requirements Under CERCLA § 108(b) for Classes of Facilities in the Hardrock Mining Industry, 82 Fed. Reg. 3388 (Jan. 11, 2017).

that sulfide-ore copper mining presents to surface and ground water.[321,322] In considering this question, the EPA concluded that modern mines may present *greater* risks, because they are so large, produce so much waste, and have to manage so much polluted water that these factors may overwhelm any progress that has otherwise been made to reduce impacts. The EPA also points out that new practices that do exist have not been in use long enough to judge their efficacy.[323]

A primary reason why mining operations are so prone to polluting water is that they do not start out with good information. The failure of environmental review to predict water quality impacts is discussed in in the Appendix C, based primarily on Kuipers, et al. (2006). Contrary to industry attempts to paint this study as outdated, we know of no evidence that the EIS process has improved to the point of accurately predicting outcomes. A perusal of the case studies in the report reveals no trend of improvement over time.[324] The report indicates that insufficient or inaccurate information for the reviewed mines pertained to hydrogeology and/or geochemistry. We have examined current practices in hydrogeological and geochemical investigation, and in both cases mines continue to be permitted based on poor-quality information. Indeed, obtaining accurate information for either may not be possible.

As the Washington Department of Ecology acknowledged in the context of the 2006 EIS for the Buckhorn Mine, "[t]he propensity for mining to pollute waters is unlikely to change in the foreseeable future."[325] Modern mining techniques do not change the fact that mining – and particularly, sulfide-ore copper mining – pollutes water.

1. The most recent mine plans include allowances for polluting water

Thus far, mining has not and cannot be done in a watery environment without impacting water in two ways. First, some amount of water spills, escapes containment systems, or (in the case of storm water) is simply allowed to seep or run off into surface waters. As long as water quality standards are not violated, degradation of high-quality waters is considered acceptable. Second, if the mine itself or waste rock or tailings disposal facilities intercept groundwater, groundwater will become contaminated. A mine that excavates or disposes of sulfide-bearing rock in northeastern Minnesota's wet environment will affect groundwater. This is why the sulfide-ore mines permitted thus far in the Midwest have been given "compliance boundaries," within which compliance with groundwater quality standards is not required.

We need look no farther than the first two sulfide-ore copper mines that have been proposed in northeastern Minnesota to understand that modern mining methods will not end pollution from mining. The NorthMet mine has been permitted to degrade water quality in the Partridge and

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321 Chambers, D.M. (2014).
322Levit, S. (2018b) *Follow-up report: Acid mine drainage and other water quality problems at modern copper mines using state-of-the-art prevention, treatment, and mitigation methods*. Center for Science in Public Participation.
323 U.S. EPA, 82 Fed. Reg. 3388.
324 EISs prepared for closure activities after the mine has ceased operating appear to be an exception, although monitoring data was not yet available in 2005 to assess all of them. These EISs were prepared after impacts had already occurred, so would be expected to have higher accuracy.
325 Wash. Depart. of Ecology (2006). *Buckhorn Mountain project Final Supplemental Environmental Impact Statement.*

Embarrass rivers.[326] It has also been permitted to pollute the groundwater under the full extent of its property holdings, which cover many square miles.[327,328] Twin Metals has not yet provided estimates of the pollution that the Maturi Mine would cause, but envisions that compliance with groundwater standards would not be required at the project site, but rather at some point "downgradient of potential Project impacts."[329] Stormwater from construction would be discharged under the statewide general permit,[330] which allows degradation up to the point of water quality standards and does not require monitoring to determine if water quality standards are met.[331] As explained in Part 2, Section A.II.g above, U.S. EPA staff believe that similar use of the general permit at the NorthMet site will result in increased mercury in surface water.

2. Mining operations like those in the Withdrawal Area are likely to be affected by mistakes, accidents, and corner-cutting

As discussed above, human error is a primary cause of releases of mining-impacted water to the environment. The propensity for human error has not changed and is not likely to change, for as long as humans remain human. The ways in which human error can result in discharges of polluted water at a mine site are limitless. Each mining operation has hundreds of workers and many systems and facilities that will impact water when mistakes are made. To say that a mine will never impact surface water is to say that no one will ever be negligent or distracted and accidents will never happen.

Mistakes are never intended, yet they occur with some frequency. A striking example is the August 4, 2014 Mt. Polley copper mine disaster in Canada, at which the tailings storage facility failed catastrophically and released at least 5 million cubic meters of mine tailings, mine effluent, and storm water into nearby creeks and pristine lakes important to the Fraser River sockeye salmon run.[332] The morning after the Mount Polley tailings basin failure, the CEO of the company that owns and operates the mine said, "If you had asked me two weeks ago if that could happen, I would say it couldn't happen."[333,334]

The Mt. Polley mine opened in 1997, and was touted as the gold standard of a "modern mine." Knight Piésold Consulting, which designed Mt. Polley's tailings dam, explained in a June 28, 2013 memorandum to the U.S. EPA (regarding a tailings dam being considered for another

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326 NorthMet FEIS p. 5-151.
327 *Id.* p. 5-14.
328 MPCA (2018a). *National Pollution Discharge Elimination System/State Disposal System MN0071013*.
329 Twin Metals (2019b), line 3053.
330 *Id.* line 1586.
331 MPCA (2018, Aug. 1). Authorization to discharge stormwater associated with construction activity under the National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) program, MNR 100001.
332 Brach, B. (2014, Aug. 6). Mount Polley mine spill threatens B.C. Sockeye salmon run. *CBC News*. Retrieved Dec. 23, 2021 from https://www.cbc.ca/news/canada/british-columbia/mount-polley-mine-spill-threatens-b-c-sockeye-salmon-run-1.2729143.
333 CBC News (2014, Aug. 6). Mount Polley mine tailings spill; Imperial Metals could face $1M fine. Retrieved Dec. 23, 2021 from https://www.cbc.ca/news/canada/british-columbia/mount-polley-mine-tailings-spill-imperial-metals-could-face-1m-fine-1.2728832.
334 Paperny, A.M. (2014, Aug 5). What's in Imperial Metals' Mount Polley tailings? Should you be worried? (Updated Sept. 9, 2014). *Global News*.

mine): "*[M]odern dam design technologies are based on proven scientific/ engineering principles and there is no basis for asserting that they will not stand the test of time.*"[335]

3. Existing advanced technology is often not used

Although the mining industry touts advanced technology as allowing modern mines to operate without "significant" pollution, individual mining companies resist using that technology in the context of a specific mine if it adds to their costs. For example, reverse osmosis water treatment is available, but it will not be required unless environmental review indicates that it is needed. Because mining companies consistently predict that the quality of water that will need to be treated at a proposed mine will be better than it turns out to be, the advanced technology that *could* prevent or reduce impacts is often not used.

An example from the NorthMet Mine is the type of railcar that will be used for transport of ore. Spillage of ore between the mine site and the processing plant is predicted to result in violations of the water quality standard for copper in between 16 and 542 acres of wetlands, and to increase the current exceedances of the aluminum standard for an even greater (unquantified) area. [336,337] Although methods are available that could eliminate spillage, PolyMet deemed them too expensive. It agreed to refurbish traditional railcars to reduce the spillage, and the regulatory agencies accepted the compromise.

"Adaptive management" is often used as a rationale to expect that new mines will not pollute water. But even if alternative methods are available and could be effective once they are known to be needed (which is not always the case), the existence of an adaptive management plan does not mean that problems will be fixed. The Washington Department of Ecology relied on the availability of adaptive management measures when permitting the Buckhorn Mine in 2007.[338] For example, in regard to surface stockpile leachate, the FEIS states, "Monitoring will be used to determine if groundwater quality is being significantly impacted away from the mine site, in which case the water capture and treatment system could be enhanced."[339] Almost immediately after mining began, the groundwater capture system proved ineffective. The Department of Ecology has been unable over the course of thirteen years to induce the company to take measures to bring the operation into compliance with water quality standards. The company was fined in 2009 for "fail[ure] to address failure of capture zone as required in adaptive management plan," and again in 2012 for "capture zone failure."[340] A 2016 Administrative Order cites

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[335] Knight Piésold (2013, June 28). Memorandum from Cathcart, J. and Galbraith, L. to Tesch, L., Re: Review of the Bristol Bay Assessment; EPA Docket ID No. EPA-HQ-ORD-2013-0189.
[336] PolyMet Mining Co. (2015, Feb. 10). NorthMet Project wetlands data package. (NorthMet FEIS ref. doc. PolyMet 2015b).
[337] PolyMet Mining Co. (2015, Feb. 13). NorthMet Project Waste characterization data package. (NorthMet FEIS ref. doc. PolyMet 2015q).
[338] Wash. Depart. of Ecology (2006).
[339] *Id.* at 3.7-72.
[340] Smith, D., & Barik, S. (2016, July 14). Recommendation for enforcement action, Docket 13638. Wash. Dept. of Ecology.

"Continuously failed to maintain capture zone."[341] Exceedances of standards continue to this day.[342] The company has challenged the Department of Ecology in court every step of the way.

As discussed in Part 2, Section A.II.h.2., mines in the Duluth Complex will be less profitable and have more waste to dispose of per ton of metal produced than mines with higher grade ore. They will therefore need to look for ways to keep their production costs down to a greater extent than more profitable mines. Twin Metals has proposed a mine with no water treatment facility as its opening gambit.[343] If the project goes forward, it will no doubt manage to produce water quality and water balance predictions that indicate that such a facility is not needed. If regulatory agencies accept those predictions and the project is permitted without a treatment plant, all the advanced treatment technology in the world will not treat the water that has to be discharged if the company's predictions turn out to be wrong.

Part 2, Section A.II.e. above explains why companies are so often wrong in their predictions of the quantity of water they will need to deal with, and in their understanding of the pathways that contaminated water will take to discharge to surface waters. Today's mining companies continue on the course of collecting and providing as little hydrogeological data as they can get away with, and today's regulatory agencies continue to permit mines with an insufficient understanding of hydrogeology. We can thus expect that the hydrological errors that have resulted in the release of contaminated waters at mines in the past will also occur at mines that are being permitted today.

4. The mining industry is not yet able to accurately predict the quality of leachate from sulfide-bearing rock

> Heed the old words of wisdom: "Those who ignore the past are doomed to repeat it." Is that why we hear that up to 90% of predictions of minesite-drainage chemistry are too low, and remain too low for newer minesites, leading to unexpected costs and adverse environmental effects for mining companies and taxpayers? The public is starting to pay closer attention to these errors and unexpected costs, with mining companies losing credibility.[344]

These words appear on the website not of an environmental organization, but of a group of Canadian mining scientists and engineers.

One of the reasons that contaminated drainage continues to be a problem at newer mines is that industry continues to fail to accurately predict the quality of leachate from disturbed rock.[345]

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[341] Wash. Pollution Control Hearings Board (2016, Aug. 18). *Crown Resources Corp. v. Wash. Dept. of Ecology*, Notice of Appeal.
[342] Wash. Dept. of Ecology (2021, Jan. 29). Notice of Violation 19581.
[343] It is unclear if the cost of a treatment facility would affect the financial viability of the project; no financial information has been made available.
[344] Minesite Drainage Assessment Group (n.d.). *Minesites, Mining and the Environment*. Retrieved Oct. 7, 2020, from https://www.mdag.com/index.html.
[345] Maest, A., Kuipers, J., MacHardy, K., & Lawson, G. (2006). Predicted versus actual water quality at hardrock mine sites Effect of inherent geochemical and hydrologic characteristics. *ResearchGate.* DOI:10.21000/JASMR06021122

These predictions are the starting point for predictions of impacts on surface and groundwater quality and the necessity for and design of water containment, collection, movement, and treatment systems.[346] If leachate water quality is expected to be better than it turns out to be, systems to prevent water pollution will be inadequate, because mining companies will not incur costs that are believed to be unnecessary.

Treatment plants may thus be designed to treat an influent with lower levels of contaminants than actually occurs; when that plant is unable to handle water with higher contaminant levels, the company may not have the money needed for a better and more expensive system, and/or may need to discharge polluted water while it builds a better plant. In another scenario, a certain amount of leachate is usually expected to seep to groundwater (whether through liners or otherwise) without treatment; this is deemed acceptable if the quality and quantity combined will not result in water quality standard exceedances at the point where groundwater discharges to surface water. If the quality of the leachate is significantly worse than expected, there may be water quality standard exceedances even if no more leachate reaches surface water than expected.

Kuipers et al. (2006) found that at 11 of 25 representative mines, insufficient or inaccurate geochemistry study was a root cause of water quality impacts. Reasons for these failures include:

- Erroneous assumptions made about the geochemical nature of ore deposits and surrounding areas
- Site analogs inappropriately applied to a new proposal
- Inadequate sampling (i.e., composite samples or samples not representative of entire site)
- Failure to conduct and have results from long-term testing before mining begins
- Failure to conduct proper tests, properly interpret test results, or apply proper models.[347]

These faulty methods are not a thing of the past; all of these factors affect the work done or being done for one or both of the first two sulfide-ore copper mines proposed in the Duluth Complex (NorthMet and Maturi).

i. Inadequate testing and faulty application of testing to field conditions

Predicting the quality of leachate begins with chemical analyses and static and kinetic testing to determine the constituency and understand the behavior of the various materials that will be excavated or otherwise exposed to water and oxygen in the mining process. Data from these studies are then manipulated to make predictions about the quality of leachate in the field.[348] While the static and kinetic tests themselves are improving and becoming more standardized, the methods used to interpret test data and apply it to field conditions are not standard and are

[346] Price, W.A. (2009). Prediction Manual for Drainage Chemistry from Sulphidic Geological Materials, MEND Report 1.20.1
[347] *See also* Maest, A.S., Kuipers, J.R., Travers, C.L., & Atkins, D.A. (2005). Predicting Water Quality at Hardrock Mines- Method and models, uncertainties, and state-of-the-art
[348] Lapakko, K.A. (2015). Preoperational assessment of solute release from waste rock at proposed mining operations. *Applied Geochemistry, 57*, 106-124. http://dx.doi.org/10.1016/j.apgeochem.2015.01.010.

subject to a great deal of uncertainty.[349] Water quality predictions continue to be based on methods that have proven inaccurate for other mining projects. Data and methods are often unavailable to the public and cannot be reviewed. The process and modeling are sometimes incomprehensible even to experts in the field.

The underprediction of water quality impacts is one of the most consistent aspects of modern mining. There are many scientific studies that examine the many geochemical factors that can affect water quality, but extrapolation from lab test results to predicted water quality in the field remains guesswork.

The problem begins with the low bar that industry geochemists set for themselves; the industry position is that it is acceptable to underpredict impacts by an order of magnitude. This is stated in a 2019 letter to the Wisconsin DNR from Foth Infrastructure and Engineering regarding the Flambeau mine: "A typically accepted tolerance for predictive geochemical models is to be within an order of magnitude."[350] A similar statement was made by a mining company geochemist at the contested case hearing for the Eagle Mine.

These statements are an acknowledgment by industry scientists that the science of water quality prediction has not yet advanced to a level of accuracy beyond an order of magnitude. This level of accuracy is insufficient for the purpose of permitting mines in water-rich environments. The difference between 3 mg/L and 30 mg/L sulfate, or 1.5 ng/L and 15 ng/L mercury, is enough to make fish unsafe to eat.[351] The difference between 8 ug/L and 80 ug/L copper is enough to empty a stream of some species of fish.[352,353] The difference between 200 ug/L and 2,000 ug/L manganese makes water toxic to human adults.[354]

Comparisons of quantitative predictions to monitoring data after mining begins are difficult.[355] For many existing mines, such a comparison is not possible. In some jurisdictions, mines either do not monitor leachate water quality (focusing instead on diluted water at downstream locations) or did not prepare quantitative leachate predictions prior to start-up. In other jurisdictions, the data may exist but are not readily available to the public. However, we have identified three modern mines for which "apples-to-apples" comparisons of leachate predictions

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[349] Maest, A.S., & Nordstrom, D.K. (2017). A geochemical examination of humidity cell tests. *Applied Geochemistry*, *81*, 109-131. http://dx.doi.org/10.1016/j.apgeochem.2017.03.016

[350] Foth (2019, April 29). Letter from Kosiki, S., and Donohue. S. to Siebert, D. and McManama, Z., Wisconsin Dept. of Natural Resources, re: Reclaimed Flambeau Mine: Summary of items discussed related to the request to modify the updated monitoring plan and annual report format.

[351] See Part 2, Section C.II.g. below.

[352] Santos, E.M., Ball, J.S., Williams, T.D., Wu, H., Ortega, F., Van Aerle, R., Katsiadaki, I., Falciani, F., Viant, M.R., Chipman, J.K., & Tyler, C.R. (2009). Identifying health impacts of exposure to copper using transcriptomics and metabolomics in a fish model. *Environmental Science & Technology*, *44*, 820–826. https://doi.org/10.1021/es902558k.

[353] Woody, C.A., & O'Neal, S.L. (2012). *Effects of copper on fish and aquatic resources*. Prepared for The Nature Conservancy. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/sw/cpa/Documents/W2013ECopperF062012.pdf.

[354] Minn. Dept. of Health (2020). *Toxicology Summary for: Manganese CAS: 7439-96-5.*

[355] Kuipers, et al. (2006) is based primarily on qualitative (rather than quantitative) predictions.

to leachate monitoring is possible. At all three, the levels of constituents in leachate were significantly underpredicted.

The first example is the Eagle Mine in Michigan. Eagle Mine began stockpiling waste rock in late 2011. After sitting in the elements for about one year, water running through the stockpile was about twice as high as predicted for several constituents – sulfate, barium, boron, cadmium, iron, and selenium. It was two orders of magnitude higher than predicted for aluminum and manganese. Water quality has deteriorated over time. The predicted sulfate concentration was 575 mg/L; the average actual concentration in 2019 was 2,317 mg/L. The predicted cobalt concentration was 0.8 ug/L; the actual concentration in 2019 was 399 ug/L. The predicted manganese concentration was 5 ug/L; the average actual concentration in 2019 was 2,070 ug/L.[356] For mine inflow water, the sulfate concentration predictions are off by a factor of 4; aluminum predictions are off by a factor of 100.[357]

The second mine is the Vangorda Mine in Yukon Territory, Canada, which was used as an "analog" for water quality predictions for the NorthMet mine (discussed below). Canada's Mine Environment Neutral Drainage (MEND) Program released a report on the Vangorda Mine in 2008 that included water quality predictions for zinc concentrations compared to actual monitoring data.[358] The predicted zinc concentration for groundwater seepage in the mine was 10 mg/L, while the average monitored level was 66 mg/L. Water quality at the site is expected to continue to deteriorate; MEND now predicts that zinc concentration in leachate will ultimately be as high as 780 mg/L.

Third is the Flambeau Mine in Wisconsin. The Flambeau Mine is closed, and the only mining waste at the site is in the pit, which has been completely filled in, so there is no leachate monitoring data per se. However, data is available for both predicted groundwater concentrations and actual groundwater concentrations. Once again, the mining company significantly underpredicted the impact. The mine permit application predicted that the level of manganese in groundwater leaving the backfilled pit would be 550 ug/L;[359] the actual level in the pit has been at least as high as 30,300 ug/L, with water at the point of migration from the pit as high as 15,000 ug/L. The copper concentration was predicted to be 14 ug/L; the actual level has been as high as 170 ug/L at the point of migration.[360]

One of the typical methods used to arrive at such faulty predictions is the application of "scaling factors" to lab test data based on the assumption that water quality in the field will be significantly better than in humidity cell tests due to differences in such things as particle size,

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[356] Predicted water quality for the Eagle Mine Temporary Development Rock Storage Area is found in Logsdon, M.J. (2005a). Technical memorandum to Kennecott Eagle Mining Co. re: Water quality from the development rock storage pad during operations.
[357] Predicted water quality for the Eagle Mine mine water is found in Logsdon, M.J. (2005b). Technical memorandum to Kennecott Eagle Mining Co. re: Water quality in underground mine during operational conditions.
[358] Slater, B., & Moodie, S. (2008). *Investigation of Predictions for Acidic Drainage at the Vangorda Plateau, Faro Mine Complex (Faro, YT)*. [Report 1.70.1]. MEND.
[359] Foth & VanDyke (1989).
[360] Monitoring data for the Flambeau Mine is taken from Wis. Dept. of Natural Resources (n.d.b). *Waste and Materials Management GEMS on the Web (GOTW) Public Access.* Retrieved Oct. 7, 2020, from https://dnr.wi.gov/wastemgmt/gotw/webpages/default.aspx.

water-to-rock ratios, and temperature.[361,362] This method generally does not account for factors that may make water quality worse in the field, such as bacteria,[363] the formation and dissolution of secondary chemicals,[364] and longer residence time for water contacting waste rock.[365] A typical assumption is that because average particle size in the field is much larger than in lab tests, rock and leachate will be slower to turn acidic in the field, but this is not always the case.[366] In short, scaling factors remain guesswork.

Often, mining companies do not allow sufficient time for humidity cell testing before they expect to obtain a permit. It is likely that some rock that will ultimately turn acidic will not do so within the time Twin Metals allowed for humidity cell tests for the Maturi Mine. The company may agree to presume that rock with a certain sulfur level may turn acidic over time, but may also insist without adequate certainty that the lag time will be long enough that the rock will not present a problem.[367]

Other methods employed to underpredict impacts include eliminating certain test results. Humidity cell test data from the first week or more (the "first flush") tends to be significantly higher in minerals than subsequent data because the rock sample has been weathering without rinsing for some time before the test begins. This data is typically discarded in test analyses,[368] but is actually reflective of conditions in the field during spring run-off and other large precipitation events following dry periods.[369] These events often result in the poorest observed water quality, and can have significant negative effects on aquatic organisms.[370,371] The "first flush" results are thus highly relevant, but are not used.

Another questionable method used to predict better water quality than humidity cell tests would indicate is to cap predicted concentrations at the levels found in monitoring data from another

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[361] Lapakko (2015).
[362] NorthMet FEIS p. 5-62.
[363] Jones, D.S., Lapakko, K.A., Wenz, Z., Olson, M.C., Roepke, E.W., Sadowsky, M.J., Novak, P.J., & Bailey, J.V. (2017). Novel microbial assemblages dominate weathered sulfide bearing rock from copper-nickel deposits in the Duluth Complex, Minnesota, USA. *Appl Environ Microbiol 83*, e00909-00917. https://doi.org/10.1128/AEM.00909-17.
[364] Maest, A.S., & Nordstrom, D.K. (2017).
[365] Parbhakar-Fox, A., & Lottermoser, B.G. (2015). A critical review of acid rock drainage prediction methods and practices. *Minerals Engineering, 82,*107–124.
[366] Lapakko, K.A., Engstrom, J.N, & Antonson, D.A. (2006). Effects of particle size on drainage quality from three lithologies. In Barnhisel, R.I. (Ed.). *Proceedings of the 7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006, St. Louis MO*, American Society of Mining and Reclamation.
[367] *See* Twin Metals Minnesota (2019a), lines 2606 to 2609 ("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.")
[368] *See* NorthMet FEIS p. A-558.
[369] Maest, A.S., & Nordstrom, D.K. (2017).
[370] Nordstrom, D.K. (2011). Hydrogeochemical processes governing the origin, transport and fate of major and trace elements from mine wastes and mineralized rock to surface water. *Applied Geochemistry, 26,* 1777–1791. doi:10.1016/j.apgeochem.2011.06.002.
[371] Hammarstrom, M., Seal, R.R., Meier, A.L., Kornfeld, J.M. (2005). Secondary sulfate minerals associated with acid drainage in the eastern US: Recycling of metals and acidity in surficial environments. *Chemical Geology*, *215*, 407– 431. doi:10.1016/j.chemgeo.2004.06.053.

"analog" mine.[372] The Vangorda Mine in Yukon Territory, Canada discussed above was one of the analog mines used to cap water quality predictions for the NorthMet Mine. Ironically, the reason given for the failure of pre-mining predictions for the Vangorda Mine was that rather than using data from humidity cell tests, the modeling used analog data from the nearby Faro Mine. The Vangorda report warns against the use of empirical data from another mine to estimate better water quality than is predicted by humidity cell tests, which is precisely what PolyMet did with the Vangorda data.

Water quality at the Vangorda Mine has continued to deteriorate since PolyMet used monitoring data from that mine as concentration caps for predictions of water quality at the NorthMet Mine.[373,374] It thus cannot even be said that the caps used were the highest concentrations found in leachate at another mine.

ii. Test samples that are not representative of all rock at the site

Another reason that geochemical testing does not result in accurate predictions is that the testing is often not representative of all rock that may produce leachate. "Best practice" for material characterization for a proposed mine is to conduct a mineral assay program for waste rock comparable to what is done to characterize ore. To produce accurate information, the block model that is typically used to define an ore body must cover waste rock as well, with a comprehensive identification of geochemical or geoenvironmental units.[375,376] Rock from all units must be characterized. A representative subset of these samples can then be chosen for kinetic testing.

This practice was not followed for the NorthMet project,[377] and it appears that it will not be followed for the Maturi Mine either. Our understanding is that Twin Metals has conducted static tests on 224 drill core samples and has begun or plans to begin kinetic testing on a subset of these.[378] Although this may sound like a big number, to our knowledge Twin Metals has made no attempt to identify or include the full range of waste rock. It does not appear that the block model has been extended to waste rock areas, or that drill core has been obtained from all of the rock that would be necessary to inform a complete model. The Maturi site includes many mineral alteration zones,[379] where rock composition is likely to vary significantly from adjacent rock. To understand potential impacts on water and the water containment and collection methods that are necessary, sufficient drilling is required to identify and map these zones and sufficient testing is required to characterize them. It does not appear that Twin Metals plans to do this work.

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[372] NorthMet FEIS p. 5-62.
[373] Denison Environmental Services (2011). *2011 Annual environmental monitoring and activities report, Faro Mine Complex—Faro, YT*. Prepared for Yukon Government Dept. of Energy, Mines and Resources.
[374] Current monitoring data can be found at *Waterline* (n.d.). Yukon Water Board, https://apps.gov.yk.ca/waterline/f?p=127:LOGIN. The relevant permit number is QZ06-075-1.
[375] Lapakko, K.A. (2015).
[376] Parbhakar-Fox, A. & Lottermoser, B.G. (2015).
[377] Maest, A. (2014). Technical memorandum to Hoffman, K., Minn. Center for Environmental Advocacy, re Comments on PolyMet's Supplemental Draft Environmental Impact Statement.
[378] Golder (2019, May 6). *Twin Metals Minnesota project, mine materials characterization program, sample selection—humidity cell testing of drill core—sample group 1 (HCT-C-1).*
[379] Duluth Metals (2014, Oct.), p. 7-15.

In regard to tailings, Twin Metals plans to create a 429-acre, 130-foot high tailings stockpile over a 25-year period. The mine that would generate these tailings would cover approximately 3 square miles. But Twin Metals plans to do only one composite test of tailings from a pilot project that used ore from one corner of the proposed mine.[380] Twin Metals describes the sulfur level of the pilot project tailings as "rang[ing] from approximately 0.08 to 0.14 wt %,"[381] but does not reveal the sulfur level of its one test sample.[382] Although Twin Metals acknowledges the need to show that the tested sample is representative of all tailings that will be produced during operations, it makes no attempt to do so.[383,384]

iii. Studies that do not include all constituents of concern

Whether inadvertently or by design, materials characterization work sometimes fails to assess constituents that end up having the greatest impact. An example from the Maturi Mine is tellurium, which is present in rock at the site.[385] It appears that tellurium was not included in static testing and is not planned for inclusion in kinetic testing. Tellurium is toxic at very low levels, and is an emerging pollutant of concern both for local aquatic systems and as a global pollutant.[386]

The release of *any* mercury into the environment – no matter how small – is always an issue of concern. Mercury is problematic at extremely low levels, measured in parts per trillion rather than parts per million as with most other metals. But the detection and quantification limits planned for Twin Metal's geochemistry work are not low enough to accurately predict mercury releases. Mercury was not included as an analyte in the static testing for which data is available. The planned kinetic testing does include mercury, but at a detection limit of 10 ng/L and a quantification limit of 50 ng/L.[387] The water quality standard is 6.9 ng/L, so mercury leachate at a level higher than the standard may not even be detected. Furthermore, mercury impacts the environment and human health at a far lower level than the standard.[388] Thus the planned humidity cell testing for the Maturi mine will not provide information necessary to understand potential impacts. Similar tactics were used to obscure likely increases of mercury in the environment at the NorthMet Mine.

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[380] Golder (2019, July 26a). *Twin Metals Minnesota project, mine materials characterization program, sample selection – kinetic testing of 2013 pilot test tailings and cemented tailings backfill.*
[381] *Id.*
[382] Golder (2019, July 26c). *Twin Metals Minnesota project, mine materials characterization program, kinetic testing of 2013 pilot test tailings and cemented tailings backfill.*
[383] Golder (2019, July 26a).
[384] Golder (2019, July 26b). *Twin Metals Minnesota project, mine materials characterization program, sample selection rationale – kinetic testing of 2013 pilot test tailings and cemented tailings backfill.*
[385] Golder (2019, May 6).
[386] Wiklund, J.A., Kirk, J.L., Muir, D.C.G., Carrier, J., Gleason, A., Yang, F., Evans, M., & Keating, J. (2018). Widespread atmospheric tellurium contamination in industrial and remote regions of Canada. *Environ. Sci. Technol.*, *52,* 6137–6145. DOI: 10.1021/acs.est.7b06242.
[387] Golder (2019, May 6).
[388] The Fond du Lac Band of Lake Superior Chippewa sets the standard to protect human health from mercury that bioaccumulates in fish tissue at 0.77 ng/L.

In summary, mining industry scientists use an array of methods to arrive at water quality predictions that consistently predict that water quality will be significantly better than it will be. Indications are that the state of science has not advanced enough to ensure accurate predictions no matter what methods are used. Judging by the NorthMet proceedings and the Maturi work to date, regulatory agencies appear willing to accept methods that have produced inaccurate predictions in the past. Under these circumstances, projects that will pollute local and downstream waters will continue to be permitted.

5. New methods often do not address the factors that actually cause releases

Where new methods or materials are used, often the factors that have caused discharges of polluted water to the environment in the past are not addressed. As an example, consider the groundwater barriers planned for the NorthMet Mine. The plan is to maintain an inward hydraulic gradient by pumping water from inside the barrier, a method that apparently has not been used in a comparable setting before. Regulatory agencies were willing to assume that this method will effectively prevent 90 to 99% of groundwater from escaping the barrier.

However, pumping from inside the barrier does not address the primary reason why barrier systems have not been effective in northeastern Minnesota and similar geologies in the past. No barrier will be 90 to 99% effective if it is not adequately keyed to bedrock. As discussed above in Part 2, Section A.II.e., the geology of the area is such that an adequate key to bedrock is likely to be impossible, for more than one reason (i.e., fractured bedrock and a bouldery till). In short, the new method does not address or change the reason why past methods have failed.

Another example is the installation of liners. While the quality of liner material may have improved over time, many liners leak because of issues with their installation, and those issues have not significantly changed. Rocks are still sharp; removing them still leaves voids. Geomembrane is still large, awkward, and difficult to maneuver. Workers and equipment still have to move over it in the process of installation. The quality of the labor force is probably not much better than it has ever been. A square mile is still a square mile, rain and snow still fall, the sun is still hot, and blackflies still bite.

Again, adaptive management is often presented as the answer to potential issues with new methods that have no track record, but the adaptive management plan often does not identify methods that would address the problems that are most likely to result in releases. For example, the discussion of adaptive management in the NorthMet EIS does not mention options if perfect installation of groundwater barriers proves impossible. The only suggestion given if the systems do not achieve the assumed 90 to 99% effectiveness is to install groundwater pumping wells downgradient to collect contaminated water. No mention is made of the cost of such a remedy, which would be expensive and would have to continue in perpetuity. Money for this purpose is not included in financial assurance.[389]

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[389] NorthMet FEIS p. 5-239.

6. The changing climate and more frequent and extreme weather events will increase the risk to water resources

A report evaluating all known tailings dam failures found that the most common cause of failure was an unusual rain event.[390] Heavy rainfalls are a common cause of other unplanned releases of polluted water as well. Precipitation can overwhelm water containment, collection, and treatment systems, discharging excess contaminated water to local streams either due to overflows or to prevent catastrophic events.

The standard use of a 24-hour, 100-year storm event (i.e., the greatest 24-hour rainfall expected to occur within a 100-year period) to size mine features is taken to mean that the system will be large enough to handle any eventuality, but even historically this has not been the case. At Zortman Landusky, four storms in 25 years exceeded the 100-year event.[391] Other mines with unplanned discharges due to heavy rainfall include Kendall,[392] Pinto Valley, Tyrone, Monrenci, Ray, Chino, and Continental.[393,394,395]

Actual precipitation events can prove too large for these systems for several reasons. Sizing is based on rainfall over a 24-hour period; but heavy rains may continue for two days or more. As was the case in the Duluth flood of 2012, those two days of precipitation may fall on geography that is already saturated from earlier rainfalls.[396] While it might seem that for the sizing of ponds and other facilities, ground saturation should not matter, it often does matter for unexpected and unconsidered reasons. Flooding at a site can result in power outages, road washouts, and the inability of workers to come to work or to access facilities. Stormwater moving over land can enter ponds and ditches, eliminating the capacity designed for process water. In addition, an actual rainfall will at some point be larger than the 100-year event, particularly with the effects of climate change.

Risks to water resources from mining are likely to increase in the future due to increasingly severe precipitation events. Northeastern Minnesota is already receiving and is projected to receive a growing number of extreme rainfall events.[397] The Duluth flood was considered to be a 500-year storm event; such an event has always been possible at any location, but is becoming more likely with climate change. One year after the Duluth storm, Minnesota Public Radio reported, "The Duluth flood is part of a growing 'extreme rainfall' trend in Minnesota. Since 2004 there have been three separate '1,000 year rainfall events' in southern Minnesota." And, "rainfall events of 3 or more inches have doubled in frequency since about 1960. . . . .

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[390] Rico, M., Benito, G., Salgueiro, A.R., D´iez-Herrero, A., & Pereira, H.G. (2008). Reported tailings dam failures: A review of the European incidents in the worldwide context. *Journal of Hazardous Materials 152*: 846–852. doi:10.1016/j.jhazmat.2007.07.050.
[391] Kuipers, et al. (2006).
[392] Mont. Dept. of Environmental Quality (1996, Sept. 18). Operating permit – field inspection report. Operating permit 00122.
[393] Gestring, B. (2019). *U.S. operating copper mines: failure to capture and treat wastewater.* Earthworks.
[394] Gestring, B. (2012). *U.S. Copper Porphyry Mines: The track record of water quality impacts resulting from pipeline spills, tailings failures, and water collection and treatment failures.* Earthworks
[395] U.S. EPA (1998, April). *Damage cases and environmental releases from mines and mineral processing wastes.*
[396] Czuba, C.R., Fallon, J.D., & Kessler, E.W. (2012). *Floods of 2012 in Northeastern Minnesota*. [Scientific Investigations Report 2012-5283] U.S. Geological Survey.
[397] Minn. Dept. of Health (2018). *Planning for Climate and Health Impacts in Northeast Minnesota*.

According to a report from climatenexus.org there has been a 31% increase in extreme rainfall events in the Midwest since 1958."[398]

Climate change has made the assumed 100-year precipitation event something of a moving target, but it continues to be used for sizing water storage facilities at mines. MDNR did not require extra capacity at the NorthMet mine to account for the potential for heavier rains due to climate change,[399] despite evidence that heavier rains were already occurring. It thus seems likely that MDNR will allow inadequate water storage capacity for mines in the Rainy River-Headwaters as well, ultimately resulting in the discharge of contaminated water to Birch Lake or its tributaries in storm and flood situations.

l. Sulfide-ore copper mining would degrade water quality, in conflict with the Outstanding Resource Value Water designation for the BWCAW

1. Sulfide-ore copper mining in the Withdrawal Area would result in surface water quality degradation

It is highly unlikely that any sulfide-ore copper mine in the Withdrawal Area would in the end meet the non-degradation standard of no net increased loading for downstream BWCAW waters.[400] An initial difficulty is that state mining regulations allow water quality degradation up to the level of water quality standards. The stated regulatory purpose and policy of the regulations is to "reduce impacts to the extent practicable [and] mitigate unavoidable impacts,"[401] rather than to prevent impacts altogether. "Mitigate" is not defined, but generally means simply to lessen the harm.[402] Short of the violation of a specific standard, the rules do not preclude degradation of water quality or other resources.

This point is emphasized by former MDNR Commissioner Tom Landwehr:

> The refrain heard from Antofagasta is that Twin Metals should be allowed to go through Minnesota's permitting process and show that it can meet "state standards." You never hear Antofagasta say it won't hurt the BWCAW. Regardless of any particular mining company's intentions, those "state standards" allow for pollution. The state standards for mining are, unfortunately, not designed to protect the BWCAW.[403]

Even the mining industry acknowledges that non-degradation of water quality is not a realistic goal for sulfide ore mines. A power point presentation by Paul Eger of Global Minerals Engineering and Frank Ongaro of Mining Minnesota suggests that for a mining operation,

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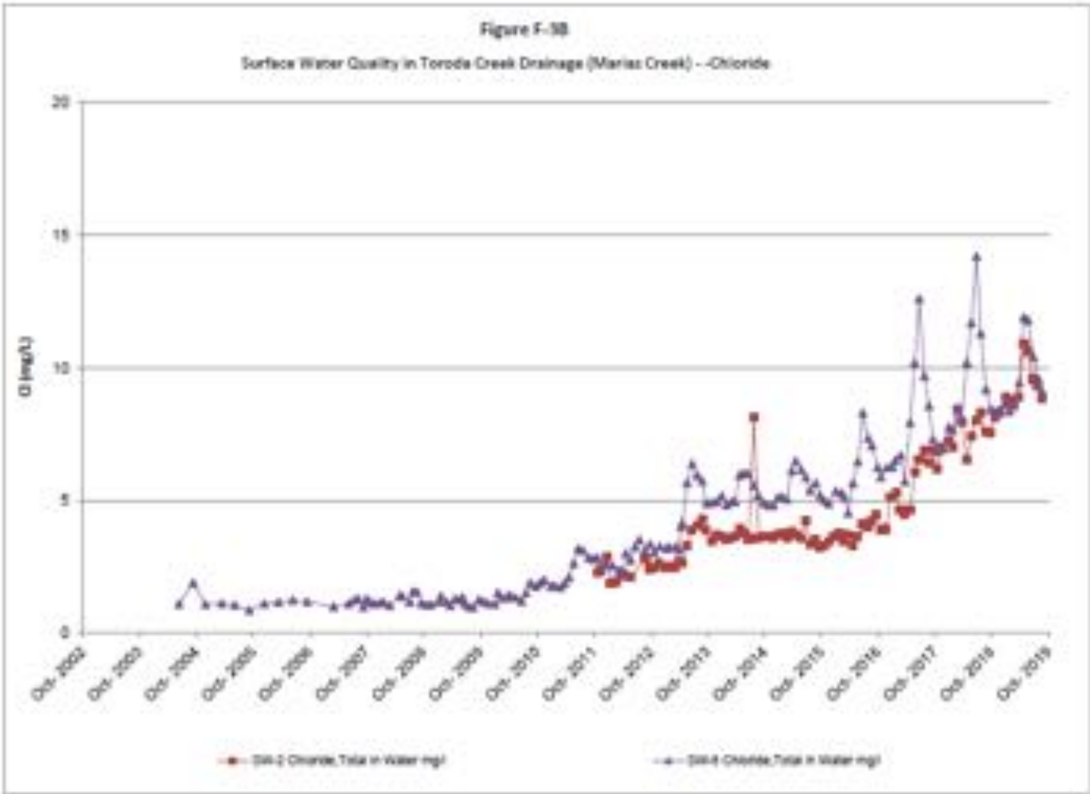
398 Huttner, P. (2013, June 20). Climate change likely 'juiced' the Duluth flood of 2012. *MPR News*. https://www.mprnews.org/story/2013/06/20/climate-change-likely-juiced-duluth-flood-of-2012.
399 NorthMet FEIS p. A-185.
400 See Part 2, Section A.II.b.3 above.
401 Minn. R. 6132.0200.
402 *Lexico.com* (n.d.). Oxford Dictionary. Retrieved Nov. 25, 2021 from https://www.lexico.com/en/definition/mitigate.
403 Landwehr, T. (2021, December 3). [Corrected] Declaration of Thomas Landwehr.

success should be measured not by whether the mine has polluted local water, but by whether it has caused exceedances of water quality standards outside of its compliance boundary.[404]

As former MDNR Commissioner Tom Landwehr indicates, this is also MDNR's position. In the NorthMet EIS, MDNR consistently held that any degradation of water short of an exceedance of a water quality standard at or beyond an "evaluation location" was insignificant and not deemed to be an impact.[405] The NorthMet mine was permitted despite the likelihood of a net increased load of mercury,[406] antimony, cadmium, cobalt, copper, lead, nickel and zinc[407] to surface waters. MDNR acknowledged that that net increased load would extend many miles downstream to the St. Louis River.[408] Mine planning for the Rainy River-Headwaters appears to be following the same course; the Twin Metals mine plan proposes allowing pollution of groundwater for an as-yet undetermined distance beyond the mine workings,[409] and contemplates that reclamation will be designed to meet water quality standards in surface waters.[410]

Perhaps it is because mining has a history of causing egregious water quality problems that the issue of incremental degradation of pristine waters is generally not mentioned, even in reports by environmental organizations. Nonetheless, it is a very real result wherever mining occurs. The Buckhorn Mine in Washington State provides an example. Buckhorn has caused hundreds of water quality standard exceedances over its short lifespan.[411,412,413,414] While the Washington Department of Ecology is focused on addressing these exceedances, however, the mine has also degraded downstream water quality at a lower level for several additional pollutants, which will never be addressed. In several creeks and springs, the ambient levels of nitrate, sulfate, chloride, and arsenic have slowly risen over the years (and at some locations, continue to rise during reclamation). As a single example, the steady increase in chloride in a local stream is shown in the following graph:[415]

[404] Eger, P., & Ongaro, F. (2014). *Successful Non-Ferrous Mining: Promise or reality?* [PowerPoint presentation].
[405] NorthMet FEIS, *e.g.,* pp. 5-15, 6-44, A-10.
[406] NorthMet FEIS p. 6-85.
[407] *Id.* p. 5-151.
[408] *Id.* p. 6-32.
[409] Twin Metals Minnesota (2019a), lines 3995 to 4000.
[410] Twin Metals Minnesota (2019b), App. B (Project reclamation plan), lines 626 to 628.
[411] Wash. Pollution Control Hearings Board (2016, Aug. 18). *Crown Resources Corp. v. Wash. Dept. of Ecology*, Notice of Appeal.
[412] Wash. Dept. of Ecology (2018, Aug. 20). Notice of Violation 15958.
[413] Wash. Dept. of Ecology (2020, Feb. 3). Notice of Violation 18021.
[414] Wash. Dept. of Ecology (2020, Aug. 25). Notice of Violation 18258.
[415] Golder (2020). *Hydrologic Data Report – Water Year 2019: Buckhorn Mine*.



As long as water quality standards are not violated, this degradation is deemed (in the words of Mining Minnesota) "success." While regulatory agencies and land managers may accept the trade-off of degraded water quality in order to promote mining in some locations, it nonetheless constitutes degradation of water quality, and is not appropriate upstream of Prohibited ORVW/ONRW waters.

2. Water quality standards are insufficient to protect resources

The common practice of allowing mines to degrade water quality up to the point of applicable water quality standards is particularly problematic for pollutants that have insufficient standards to protect aquatic life, wildlife, and human health. We do not attempt a comprehensive survey of all such pollutants, but limit the discussion to mercury, sulfate, and total dissolved solids/specific conductivity.

i. Mercury

As discussed below in Part 2, Section C regarding aquatic resources, mercury in wetlands and surface waters at very low levels can bioaccumulate up the foodchain and result in mercury in fish tissue that is unsafe for wildlife and human consumption. Pursuant to U.S. EPA studies, the water quality standard for mercury in ambient water throughout the Great Lakes basin is set at 1.3 ng/L limit, the level EPA found necessary to protect wildlife.[416] In contrast, discharges of up

[416] Minn. R. 7050.0220, subp. 4a(B)(16).

to 6.9 ng/L are allowed in the Rainy River basin.[417] This is despite the fact that every pertinent factor is identical in the Minnesota portion of the two watersheds, which are separated by a low divide that crosses the Duluth Complex near the head of Birch Lake. The focus in environmental review and mine permitting on meeting water quality standards is likely to mean that mercury and sulfate will be allowed to increase in the environment to an even greater extent in the Rainy River basin than in the Lake Superior basin, despite the ORVW/ONRW status of downstream waters.

ii. Sulfate

While most health benchmarks and environmental standards apply to total mercury, it is methylmercury that bioaccumulates to toxic levels in living organisms and makes fish unsafe to eat. Sulfate plays a role in the methylation of mercury, so it is important to consider increases in sulfate when assessing the potential for increased mercury in fish tissue.[418] The mechanisms involved and their impact are discussed below in Part 2, section C. There is no regulatory mechanism for this assessment. The wild rice standard of 10 mg/L sulfate is not and was not intended to be protective in regard to mercury in fish tissue, and yet we are unaware of any project, mining or otherwise, that requires sulfate levels be maintained at a lower level than 10 mg/L.

Furthermore, the 10 mg/L sulfate standard applies only to wild rice waters. If a waterbody is not listed as a wild rice water, there is no standard to protect against other environmental harms.

iii. Total dissolved solids/specific conductivity

One of the most common and ubiquitous impacts of mining on local waters is an increase of total dissolved solids (TDS) and specific conductivity.[419] As discussed in Part 2, section C below, specific conductivity impacts the abundance of aquatic species at levels of 300 µS/cm or above.[420] In unimpacted waters in Minnesota, background specific conductivity has a median value of about 65 µS/cm.[421] In contrast, downstream waters affected by mining in Minnesota have specific conductivity levels that are often above 1,000 or even 2,000 µS/cm. The following observations apply to discharge from the Dunka Pit stockpiles *after* it has run through a passive wetland treatment system:

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[417] Minn. R. 7052.0100, subp. 4.

[418] Myrbo, A., Swain, E.B., Johnson, N.W., Engstrom, D.R., Pastor, J., Dewey, B., & Peters, E.B. (2017a). Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction to sulfide in experimental wetland mesocosms. *Journal of Geophysical Research: Biogeosciences*, *122*, 2769–2785. https://doi.org/10.1002/2017JG003788.

[419] Although there is not an exact correlation between TDS and specific conductivity, they refer to the same pollutants and are used interchangeably here.

[420] National Center for Environmental Assessment (2011). *A field-based aquatic life benchmark for conductivity in central Appalachian streams*. [EPA/600/R-10/023F]. U.S. EPA.

[421] Thingvold, D., Sather, N., Ashbrook, P. (1979, Dec.) *Water Quality Characterization of the Copper-Nickel Research Area*. Minnesota Environmental Quality Board. pp. 7-19. Available at https://www.leg.mn.gov/docs/pre2003/other/CN153.pdf.

> Even after dilution of Dunka discharge with clean water from approximately one mile of the unimpacted portions of the watershed, [Discharge Monitoring Report]s document that the specific conductance in Unnamed Creek, before it enters Bob Bay of Birch Lake, reaches between 800-900 µS/cm. In the winter, when wetland discharge flows are diminished, concentrations are substantially higher. Recently, from January through May 2014, Unnamed Creek data showed that even Minnesota's [former] irrigation standard of 1,000 µS/cm is often exceeded downstream of Dunka, with sampling data respectively for each month of 1,225 µS/cm, 1,255 µS/cm, 1,111 µS/cm, 936 µS/cm, and 417 µS/cm. (Cliffs NPDES DMRs) The more concentrated creek water forms a measurable density current of higher specific conductance along the bottom of Bob Bay.[422]

At the Minntac Mine, monitoring four miles downstream in the Dark River showed a specific conductivity level above 2,000 µS/cm in seven out of ten samples taken in 2012 through 2014. Ten miles downstream where the Dark River becomes a trout stream, five out of ten samples had a conductivity level above 1,000 µS/cm.[423]

In addition to the typical increase in TDS from standard sources at any mine site, very high levels of TDS from underground sources may be breached at some mines. The NorthMet FEIS notes that "saline groundwater [defined as TDS greater than 35,000 mg/L] is known to occur in bedrock across the Canadian Shield."[424] "Brackish to saline groundwater is encountered sporadically in deep (greater than 1,000 ft) bedrock wells in northeastern Minnesota."[425] Saline groundwater was encountered at the AMAX test shafts in the Duluth Complex "at depths of approximately 1,200 to 1,400 ft bgs (elevation 200 to 400 ft amsl)."[426] The Federal Hardrock Mineral Prospecting Permits Project Record of Decision also recognizes the release of saline groundwater as a risk of mine-related drilling.[427]

The Maturi mine plan calls for mining as deep as 4,500 ft bgs.[428] Considering the size of the site, very minimal data on groundwater quality is currently available. Nonetheless, elevated TDS was found in one shallow bedrock well, with a TDS level of 3350 mg/L and specific conductivity of 3651uS/cm. Given the extent of proposed excavation into deep bedrock, releasing saline groundwater at some location would be likely.

Minnesota does not have a numeric water quality standard that is intended to protect aquatic life from TDS or specific conductivity, despite MPCA acknowledgement that aquatic life is harmed by this pollutant.[429] The former standard that was set to protect agriculture and industrial use also

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[422] Johnson, B.L., & Johnson, M.K. (2015). An evaluation of a field-based aquatic life benchmark for specific conductance in northeast Minnesota. Prepared for WaterLegacy.
[423] MPCA (2016a).
[424] NorthMet FEIS p. 5-131.
[425] Morton. P, & Ameel. J, (1985, July). *Saline waters as indicators of economic mineralization*. Report submitted to Minnesota Department of Natural Resources Minerals Division.
[426] Barr Engineering (2012). Technical memorandum: response to questions on saline groundwater. (NorthMet FEIS, ref. doc. Barr 2012m).
[427] U.S. Forest Service (2012, May). *Federal hardrock mineral prospecting permits Final Environmental Impact Statement, Cook, Lake, St. Louis, Koochiching Counties, Minnesota*. U.S. Dept. of Agriculture.
[428] Twin Metals Mining (2019a), Cover letter.
[429] MPCA (2021, Feb. 24). *In the Matter of Proposed Amendment to Minnesota Rules Chapters 7050 and 7053, OAH Docket # 8-9003-37102, MPCA Post-Hearing Response to Public Comments.*

provided some protection for aquatic life, but MPCA has recently loosened that standard to the point where TDS and specific conductivity are essentially unregulated.[430] The current regulatory situation is such that harmful levels of TDS are likely to be allowed in discharge to surface waters from any mine in the Duluth Complex.

m. Sulfide-ore copper mining presents significant risks of downstream surface water contamination from contaminated groundwater and pit lakes

Because sulfide-ore copper mining leaves large areas of contaminated groundwater, it is inherently risky for adjacent and downstream waters. While regulatory agencies and public land managers may deem these risks acceptable in some locations, these risks are not appropriate for the waters of the BWCAW and VNP.

The hazards of large sites with contaminated groundwater are well enough known that they do not need explication here. Sulfide-ore copper mining by its very nature creates such sites whenever mines or mining facilities intercept groundwater, and in the Rainy River-Headwaters, all mines will intercept groundwater. This is not a possibility or a "worst case scenario," it is a certainty. These contaminated sites are very much the same as other contaminated sites in their threat to connected, downstream waters. This is why so many sites on the Superfund list are mine sites.[431]

Because mining cannot be done without contaminating groundwater, regulatory regimes designate “compliance boundaries,” areas within which groundwater is allowed to exceed groundwater standards. The result is often not just small excursions above standards, but extremely high levels of toxic heavy metals.[432] Generally, groundwater is protected as a source of potable water;[433] mine permitting essentially designates sacrifice zones, where groundwater will not be able to be used for what is considered to be its “highest and best” purpose.

A compliance boundary will be needed for any mine that is sited in the Duluth Complex. If mining projects are considered on federal land, federal land managers will likely follow the past practice of looking to state law to determine the permissible size of the compliance boundary. Minnesota is unusual in that it allows very large areas as sacrifice zones compared to other mining states.

The allowable size of these zones is typically established by regulation. For example, Michigan sets the default compliance boundary at 150 feet from the pollution source but allows a boundary up to 1,000 feet if a number of conditions are met,[434] while Wisconsin allows a compliance

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[430] *See* Appendix C.
[431] U.S. EPA (2020, Sept. 3). *Abandoned mine lands: Site information*. Retrieved Jan. 9, 2022 from https://www.epa.gov/superfund/abandoned-mine-lands-site-information.
[432] Predicted concentrations for the NorthMet Mine are provided in PolyMet Mining Co. (2015, Feb. 27). *NorthMet Project Water Modeling Data Package – Vol. 1, Mine Site* (NorthMet FEIS ref. doc. PolyMet 2015m), Attachment G.
[433] Minn. Stat. § 103G.005(17); Minn. R. 7060.0300(6), .0400, .0600(2).
[434] Mich. R. 323.2224(1)(c), 425.406(5)(b).

boundary up to 1200 feet from the source.[435] In Minnesota, solid waste disposal sites are allowed a compliance boundary of 200 feet from the boundary of the waste.[436]

In contrast, Minnesota has no written regulation regarding compliance boundaries for mining operations, and Minnesota agencies allow mining companies to contaminate groundwater up to the property boundary.[437,438] This allows the pollution of enormous areas of groundwater--many square miles-- that is likely to become impossible to contain. In some locations at the NorthMet site, the property line is a mile or more away from a likely pollution source.[439] Twin Metals is relying on this policy to allow groundwater contamination downstream of the Maturi site.[440] If the Duluth Complex were to be fully developed upstream of the BWCAW, the result could be many contaminated sites, with all their attendant risks, cumulatively threatening BWCAW waters.

MDNR and MPCA also allow the creation of pit lakes that do not comply with water quality standards,[441] a practice that does not appear to be allowed in many mining states.[442] For example, Kuipers et al. (2006) report that for the Golden Sunlight Mine in Montana, "No pit pond would be allowed to form if it exceeds Montana surface water quality standards."[443] In Nevada, pit lakes must meet groundwater quality standards if they are not terminal, and must also show that they do not pose a threat to human, terrestrial, or avian life.[444] For the 25 mines reviewed in the Kuipers et al. (2006), 5 of the EISs were comparable to the NorthMet EIS in providing little or no information on pit lake water. Seven were either underground or dry mines. Of the remaining 13, 10 were required to either prevent a pit lake from forming or ensure compliance with water quality standards. Minnesota thus appears to be (at best) in the bottom half of U.S. mining states when it comes to allowing the creation of a polluted lake.

Northeastern Minnesota does not have terminal lakes (i.e., lakes with no outflow to other waters). In the Rainy River-Headwaters watershed, polluted pit lakes will thus always present a risk of discharge to downstream waters.

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[435] Wis. R. NR 182.075.
[436] Minn. R. 7035.2815(4)(C)(2).
[437] *See* MPCA (2018a). *National Pollution Discharge Elimination System/State Disposal System MN0071013*.
[438] MPCA rejected the property line as an appropriate boundary for compliance for solid waste facilities because of containment issues. MPCA (1988). *In the matter of proposed rules governing solid waste management facility permits, and the design, construction, and operation of solid waste management facilities, Statement of need and reasonableness*.
[439] NorthMet FEIS Figures 5.2.2-7 and 5.2.2-9.
[440] Twin Metals Minnesota (2019b), lines 3051 to 3054.
[441] NorthMet FEIS p. 5-447.
[442] A comprehensive analysis was not undertaken, but preventing the formation of polluted pit lakes may be more practicable in landscapes with less water.
[443] Kuipers, et al. (2006).
[444] Nevada Division of Environmental Protection (n.d.). *Pit lakes.* Retrieved Nov. 19, 2021 from https://ndep.nv.gov/uploads/land-mining-faq-docs/Pit_Lakes.pdf

n. Environmental review and permitting processes would not provide adequate protection for the BWCAW and Withdrawal Area

Twin Metals and other mining companies argue that they should be allowed the opportunity to lease minerals, propose a mine plan, and show through environmental review and permitting that their mining operation would not harm water or other resources, even upstream of the most high-quality, highly valued waters. Following this course in the Rainy River-Headwaters would be unwise. As discussed above, permitting and environmental review focus on meeting regulatory standards; in the Rainy River-Headwaters, those standards are not strict enough to protect the high-quality resources for which the BWCAW and the Birch Lake/South Kawishiwi River area are valued. Moreover, sulfide-ore copper mining always presents risks to downstream waters, regardless of the quality of the mine plan; those risks are not appropriate for such high-quality, highly valued waters.

Another fundamental reason why the Forest Service's proposed Withdrawal is critical is rooted in the persistent failure of environmental review to accurately predict water quality impacts.[445] Land managers and regulators can have the best intentions of accepting only a plan that will be protective, but the science of prediction is not advanced enough to know beforehand if a particular plan will in fact protect water.

Furthermore, much of the work of producing predictions has always been and will remain in the hands of the mining company that has proposed a mine. While environmental review documents are the responsibility of government agencies, those agencies often do not have the resources to undertake the amount of work necessary for thorough environmental review of a modern mine plan. Mining companies have an enormous incentive to produce evidence that indicates that their mines will meet whatever standards regulatory agencies say must be met to obtain a permit. They will not receive the permit if they do not make that showing. It may be that mining companies honestly believe their own predictions, but the reality is that the predictions are usually wrong. Every new mine is preceded by a review that indicates that the mine will meet applicable standards, but most mines do not. The high risk that environmental review will fail to accurately predict impacts makes sulfide-ore copper mining inappropriate for the Rainy River-Headwaters.

And finally, even for mines on federal lands, state regulatory agencies are important partners in making sure that standards are met and remedial action is taken as needed. Many of the requirements that would be designed to prevent a mine from polluting would be found in a state permit to mine and a state-issued NPDES/SDS permit, and the state would have primary responsibility for enforcement. It is therefore important to consider state law and practices in assessing whether mining should be allowed upstream of valuable federal resources.[446]

o. Pollution of the BWCAW cannot be effectively remediated

Once polluted water escapes mine facilities and impacts high-quality surface or ground water, that water will never be returned to its previous high-quality condition. As described above in Part 2, Section A.II.k.3., regulators often rely on the availability of "adaptive management" in

[445] Kuipers, et al. (2006).
[446] For further discussion of these topics see Appendix C.

their acceptance of mine plans with significant uncertainties. However, adaptive management will not return the environment to its condition before the pollution began.

First, it is often difficult to determine the exact cause or route of the pollution, and thus what measures will address it. The less complete the hydrogeological investigation, the more uncertain the pathways and sources that result in discharges to surface water or to groundwater beyond the compliance boundary. As discussed in Part 2, Section A.II.e., monitoring may reveal that pollution is being discharged to surface water or is moving beyond the groundwater compliance boundary, but fail to reveal the source.

Once an unanticipated discharge to surface water begins, remediation will not return that water to a pristine condition. It is important to understand that a decision to permit a mine is a decision to allow water quality degradation up to the point of water quality standards, rather than a decision to allow water quality as predicted in an EIS. In situations where water quality is worse than predicted in environmental review but does not exceed standards, there will be no remedy. If remedial action is undertaken, returning the water to its original condition (or to the quality predicted by the EIS) will not be the goal. The best that would be required is compliance with standards.[447]

Contaminants with insufficient standards (such as sulfate and TDS) or no standard at all (such as manganese) can easily reach the level of deleterious effects on aquatic life in mining-impacted waters; these issues are unlikely to be addressed in remedial actions. This is inherently problematic for high-quality waters in a wilderness or semi-wilderness recreational area, and particularly for waters with an ORVW designation.

Even for contaminants with water quality standards, exceedances of those standards will not necessarily result in remedial action. Variances or “compliance schedules” without end dates are sometimes given to mining operations that cause exceedances of water quality standards but aver that they cannot afford to remedy the situation.[448]

Furthermore, remedial activities that are available in other locations may not be appropriate in the Rainy River-Headwaters. Remedies may involve additional wells, pumping, a treatment plant, and/or other facilities that would add to the industrial landscape that has already impacted the recreational and wilderness character of the area. Remedial activities at downstream locations may not be allowable due to proximity to the BWCAW. Former U.S. Forest Service Chief Tidwell recognized this reality when he denied consent to the renewal of Twin Metals’ leases:[449]

> If TMM ultimately conducts mining operations on lands subject to its two leases and they result in AMD, metal leaching, and water contamination, very few of the available containment and remediation strategies would be compatible with maintaining the BWCAW’s quality and character. Available containment and remediation strategies such

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[447] *See* MPCA (n.d.k). *Minnesota Groundwater Contamination Atlas*. Retrieved July 27, 2021 from https://www.pca.state.mn.us/data/minnesota-groundwater-contamination-atlas (describing remedy targets for hazardous waste cleanups in Minnesota).

[448] See discussion of the Dunka Pit mining area in Appendix C.

[449] U.S. Forest Service (2016, Dec. 14).

> as sediment basins, water diversions, or construction and long-term operation of water treatment plants have the potential to deleteriously affect the BWCAW. Of particular concern given the location of TMM's leases, is the effectiveness of available methods to counteract AMD in the case of seepage, spills, or facility failures.

The potential for remediation of pollution becomes even less likely after mining ends. When an unanticipated release of contaminated water occurs after the mining company is gone, or has declared bankruptcy, it is unlikely to be addressed unless it is catastrophic. As shown by the Dunka Pit situation, regulators and legislators are more likely to accept degradation of surface waters than to institute costly remedies using public funds.[450]

Even when the mining company is still in existence, however, addressing pollution from mining operations after it occurs is fraught with difficulty. As illustrated by the Buckhorn situation, mining companies have many ways of resisting or delaying expenditures on costly remedial activities, including, to name a few, data manipulation, stonewalling, and serial litigation.[451,452] Having a similar dynamic of degradation and delay play out in the Rainy River-Headwaters as a result of new sulfide-ore copper mining in the Withdrawal Area could prove catastrophic.[453]

Remediation can also be difficult when discharge and operating permits do not provide adequate requirements. Twin Metals has proposed in its Maturi mine plan that there would be no enforceable limits for pollutants in surface waters affected by the project.[454] Thus, for instance, if monitoring showed significant elevation of sulfate in wild rice areas of Birch Lake immediately downgradient of mine facilities, no enforcement action could be taken; response would be limited to "further investigation." Furthermore, the company proposes that even the trigger points for further investigation be located an unspecified distance "downstream of potential Project impacts." While the Maturi mine plan is just a proposal at this point, it mirrors the provisions of the recently issued NorthMet permit.

Once surface waters are contaminated in the Rainy River-Headwaters, it will not be possible to prevent pollutant loads from flowing downstream into the BWCAW. The proposed Withdrawal is essential as the most certain and efficient method of preventing proposed new sulfide-ore copper mining and protecting the high-quality water and other resources of the Withdrawal Area, the MPCA, and the BWCAW downstream.

B. The proposed Withdrawal is essential to protect the BWCAW, VNP, and other areas from air emissions and fugitive dust generated by sulfide-ore mining

Mining invariably produces large volumes of air pollutants, particularly in the form of fugitive dust, which reach water through deposition. Absent the Withdrawal, sulfide-ore copper mining would generate air pollution that would have impacts in the Withdrawal Area, the MPA, the

[450] Interstate Technology & Regulatory Council (2010, August). *Case Study - Dunka Mine, Minnesota*. Mining Waste Treatment Technology Selection Web. Washington D.C.
[451] *See, e.g.,* Wash. Pollution Control Hearings Board (2015, July 30). *Crown Resources Corp. v. Wash. Dept. of Ecology*, PCHB No. 14-018, Findings of Fact, Conclusions of Law and Order.
[452] MPCA (2016a).
[453] Dayton, M.B. Gov. (2021, Dec. 1). Declaration of Mark B. Dayton, 40th Governor of the State of Minnesota.
[454] Twin Metals Minnesota (2019b), lines 3037 to 3044.

BWCAW, and VNP. Air emissions from mines in the Rainy River-Headwaters would be created by a range of activities, equipment, and movement of air over new landforms tailings piles. Mobile and fugitive dust emissions would be created by heavy truck traffic (for the Maturi project alone, some 18,000 added truck trips per year),[455] by the operation of heavy machinery, and by wind gusts entraining tailings dust. Mine exhaust ventilation raises, portals, conveyor systems, drop points, crushers, SAG and ball mills, processing and paste reagent materials silos, roads, lay-down areas, ore and waste rock stockpiles, heavy equipment emissions, concentrator facility – all would generate air emissions. Blasting would mobilize large amounts of particulate matter including PM10 and PM2.5, and generate blasting gases including NO_2, NO, and CO, which are haze precursor compounds as well as being dangerous in their own right.[456,457]

With the Maturi mine project proposed by Twin Metals, there would be at least two and likely four exhaust ventilation raises and both of the mine decline tunnels operating continuously to vent blasting gases and ore particulate matter from mine workings into the air along the South Kawishiwi River and Birch Lake. Fugitive dust emissions would be blown from waste rock and ore stockpiles along Birch Lake, from the tailings pile located along Keeley Creek and Birch Lake, and from haul-truck traffic on gravel roads.

Both point source emissions and fugitive dust would contain sulfides and sulfate, unrecovered target metals and unwanted heavy metals, and unrecovered beneficiation chemicals and other materials. Aerial deposition of these pollutants would reach water by direct deposition, by deposition to wetlands, or by being washed in precipitation from vegetation and uplands.

The deposition of pollutants from air emissions can impact water quality and aquatic systems.[458,459] Any deposition of air pollutants directly into the BWCAW or to watersheds flowing into the BWCAW would represent a new and additional contamination of BWCAW wetlands and water quality and would harm aquatic resources, as explained in Part 2.C., below.

In addition, as discussed below in Part 2.E.III. regarding impacts on wilderness character, fine particulate matter (PM2.5) and haze precursor compounds reduce visibility and, because of their small size, are carried long distances. New sources in the Withdrawal Area would affect visibility in the BWCAW and VNP, Class I areas owed the highest level of protection available from air pollution pursuant to the federal Clean Air Act. As discussed below in Part 2.G.II., air pollutants like fine particulate matter and elongated mineral fibers also pose risks to the health of visitors and residents of areas and communities affected by air pollution.

[455] Twin Metals Minnesota (2021, March 12). Scoping Environmental Assessment Worksheet Data Submittal Update, pp. 234 (Table 7-23) and 319.
[456] New South Wales Environmental Protection Authority. (n.d.). *Mine blast fumes and you*. [Factsheet].
[457] Mainiero, R., Harris, M. & Rowland, J. (2007). Dangers of toxic fumes form blasting. *Proc. 33rd Conf. on Explosives and Blasting Technique, 1,* 1-6.
[458] U.S. EPA (2000, June). *Deposition of air pollutants to the Great Waters: Third report to Congress*.
[459] Galloway, J.N., Thornton, J.D., Norton, S.A., Volchok, H.L., & McLean, R.A.N. (1982). Trace metals in atmospheric deposition: A review and assessment. *Atmospheric Environment* 16, 1677-1700.

In addition, sulfide-ore copper mining requires significant amounts of electric power and natural gas-fired heating, resulting in additional air pollution and greenhouse gas emissions. Power emissions would likely be supplied at least in large part by coal-fired power station(s).[460]

I. Mining facilities are the largest sources of fugitive dust in Minnesota, and already affect the region

Mines emit large volumes of fugitive dust, some of which is high in sulfur and metals and most of which settles within a relatively small area downwind of the source(s). As with other pollution, fugitive emissions can be a problem for any development, but mines dwarf other types of facilities in their releases. Minnesota's taconite mines are seven of the nine largest emitters of particulate matter (PM) in Minnesota; the only other PM emitters in the same order of magnitude are the state's two largest coal-fired power plants.[461] In Minnesota, taconite mining operations – and particularly their tailings facilities – create windblown dust problems for local communities, including residences that are miles from the source, and have been subject to MPCA enforcement actions.[462,463] While emissions from stacks disperse over a larger area, they can and do also contribute to water quality degradation in local waters. The analysis done for the NorthMet project indicates that mining emissions and fugitive dust would increase sulfur and metals in wetlands at that site.[464]

II. Drystack tailings facilities are particularly problematic for fugitive dust

Fugitive dust is a particular problem for drystack tailings facilities, which is the type of tailings disposal facility proposed for the Maturi project. Fugitive dust from the drystack at the Greens Creek Mine in Alaska was identified as a problem in a 2013 EIS for a tailings basin expansion project.[465] Despite a commitment to increased mitigation measures, it was still identified as an ongoing issue in a 2018 audit.[466] Similarly, at the Red Dog Mine sampling of tundra "indicated elevated lead and zinc downwind of the mine . . . as the result of the deposition of metal-bearing fugitive dust."[467] Freeze-thaw cycles exacerbate the problem in cold climates for both wet and dry facilities.[468]

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[460] *See* Duluth Metals (2014, Oct.), pp. 21-17 (Table 21-10), 1-33 (estimate of total power consumption), 1-18 (estimated production life).
[461] MPCA (n.d.l). *Permitted facility air emission data.* Retrieved Jan. 4, 2022, from https://www.pca.state.mn.us/air/permitted-facility-air-emissions-data
[462] MPCA (2016b). Fourteen dust emission events impact Iron Range residents. [Press release].
[463] Duluth News Tribune (2012, May 3). Magnetation pays $40,000 fine for dust violations.
[464] PolyMet Mining Co. (2015, Feb. 10). *NorthMet Project Wetlands Data Package*. (NorthMet FEIS Ref. doc. PolyMet 2015b).
[465] U.S. Forest Service (2013). *Greens Creek Mine tailings disposal facility Final Environmental Impact Statement and Record of Decision.* U.S. Dept. of Agriculture.
[466] Hecla Greens Creek Mining Co. (2019). *Greens Creek Mine final environmental audit.*
[467] Alaska Dept. of Environmental Conservation (2007). *Memorandum of Understanding between the State of Alaska Department of Environmental Conservation and Teck Cominco Alaska Incorporated relating to fugitive dust at the Red Dog Mine.*
[468] Zwissler, B. (2016). *Dust susceptibility at mine tailings impoundments: Thermal remote sensing for dust susceptibility characterization and biological soil crusts for dust susceptibility reduction*. [Dissertation, Michigan Technological University]. https://digitalcommons.mtu.edu/etdr/309

MDNR noted fugitive dust as an issue for drystack tailings facilities in its response to Twin Metals' data submission for state environmental review,[469] and also in response to requests to consider drystacking as an alternative for the PolyMet mine.[470] In regard to the latter, MDNR stated,

> Another potential environmental challenge for dry stacking of tailings is the generation of fugitive dust. If tailings are dry, they are easily entrained in the air and carried by the wind, given their small particle-size. While wet tailings can be transported in slurry form through a pipeline, dry stack tailings must be transported by other means – generally by truck or conveyer belt. These transportation processes are likely to result in emissions of airborne fugitive dust. This dust may contain reactive materials, such as sulfur, or heavy metals leached from the "dry" tailings. Trucks and other heavy equipment required for other phases of dry stacking would also create additional air emissions.
>
> Further fugitive dust emissions from dry tailings are likely to occur from storage or disposal areas. In wet climates, fugitive dust containing reactive minerals could pose a significant risk to the surrounding environment. Fugitive dust released into the forests, lakes and communities of northeast Minnesota would pose environmental risks.

III. It is unclear whether or how fugitive dust that affects water quality in Prohibited ORVW waters would be regulated

Emission standards set pursuant to the Clean Air Act are not designed to protect water, but surface waters can be impacted by deposition of air pollutants. As explained in Part 2, Section A.II.b.3. above, waters within the BWCAW are subject to a "no degradation" standard. It is unclear if or how this standard would be applied to air pollutants that contaminate water quality in permits for a specific mine. The MPCA has expressed concern that its ability to protect surface waters from air pollutants in individual permit proceedings may be limited by changes in U.S. EPA interpretation of the federal Clean Water Act.[471]

A particular problem for gauging the effectiveness of predictions and mitigation measures regarding aerial deposition of fugitive dust is the failure to conduct baseline testing and to require adequate monitoring. Throughout the more than ten years of environmental review for the NorthMet mine, no baseline water quality testing of wetlands was conducted, nor was any testing done to determine current levels of metals of concern in precipitation and dry deposition. While baseline water quality testing at several wetland locations for a few parameters (not including metals other than mercury) was ultimately required before mining began, those locations will not be monitored during operations. Monitoring during operations will be limited to copper, cobalt, sulfate, and hardness at two locations in one wetland. Other wetlands that may be more affected due to background conditions (e.g., a naturally lower pH and/or less dilution by

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[469] MDNR (n.d.a). *Twin Metals Minnesota EIS scoping: RGU comments on proposer's initial data submittal*. (E.g., Comments 143 and 290).
[470] MDNR (2018, Nov. 1). *NorthMet Project Dam Safety Permits, Findings of Fact, Conclusions, and Order of Commissioner.*
[471] MPCA (2019, Aug. 22). Letter from Kessler, K., Asst. Commissioner, to Kasparek, L., U.S. EPA, Re Minnesota Pollution Control Agency Comments Regarding the U.S. Environmental Protection Agency's Proposed Rule, "Updating Regulations on Water Quality Certification," Published August 22, 2019, at 84 FR 44080.

groundwater and less outflow of affected precipitation) or by leachate to groundwater from nearby facilities will not be monitored. Methylmercury in wetlands will not be monitored.[472]

IV. Use of standard controls for fugitive dust are uncertain and/or ineffective

Many mines experience fugitive dust problems despite permit requirements that are supposed to prevent them and an EIS that predicted they would not be an issue. Despite the addition of modeling of deposition impacts, mines that ultimately impact land and water through air deposition continue to be permitted.

Failures to accurately predict air deposition stem in part from the use of uncertain emissions factors in modeling, a faulty assumption that dust control measures will achieve a certain level of reduction, or both. Regarding the latter, mitigation measures are of uncertain efficacy and often do not control fugitive dust to the extent assumed. Similar to the use of BMPs for runoff, the use of a specific control measure does not guarantee a particular level of success at controlling fugitive dust. For example, a regulatory agency may assume that spraying a road with water at given intervals will control 90% of the dust that would otherwise arise from heavy truck traffic. That efficacy is uncertain, and in practice it may be that on many days, only 80% or even 70% of the dust is controlled; on those days, the road will produce 2 to 3 times as much dust as was assumed in modeling and environmental review. But as long as the company is spraying the road at the prescribed intervals, it will be in compliance with its permit.

Continuing with the same example, modeling uses an emission factor that estimates the amount of dust that will enter the atmosphere from the road under a certain level of traffic (prior to spraying) that is also highly uncertain. As the Copper-Nickel Study report put it, modeling "is heavily dependent on accurate input of emission factors. These emission factors are often based on a number of assumptions and best guesses, each of which may be off by 50 percent or more."[473]

Air emissions modeling uses emission factors developed by the EPA.[474] The accuracy of these factors has not noticeably improved since the 1970s. The EPA ranks emission factors used in modeling based on their uncertainty, and in fact has a separate document focused wholly on this uncertainty.[475] For unpaved roads (for example), the EPA advises that in many cases the certainty of emission factors for roads will be rated as a "D" (or "poor") on a scale of A to E.[476]

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[472] MPCA (2018, Dec. 20). Letter from Stine, J.L., Comm'r, to Konickson, C., U.S. Army Corps of Engineers, and Saran, J., PolyMet Mining Inc., re: 1999-5528-JKA 401 Poly Met Mining, Inc. St. Louis County, Minnesota, Section 401 Water Quality Certification.

[473] Ashbrook, P. (1979). *Impacts of fugitive dust emissions from a model copper-nickel mine and mill.* [Draft report]. Minn. Dept. of Environmental Quality.

[474] U.S. EPA (n.d.b). *AP-42, Compilation of air emissions factors*. [U.S. EPA webpage; online only] Accessed Jan. 15, 2022 via https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors.

[475] RTI International (2007). *Emissions Factor Uncertainty Assessment.* [Draft report]. Prepared for U.S. EPA. https://www3.epa.gov/ttn/chief/efpac/documents/ef_uncertainty_assess_draft0207s.pdf

[476] U.S. EPA (2006b). Chapter 13.2.2, Unpaved Roads. In *AP-42, Compilation of Air Emissions Factors*. Retrieved Sept. 23, 2020, from https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

The EPA acknowledges the difficulty presented by the uncertainty of emissions factors for environmental review, and states, "How emission factor uncertainty affects or can be incorporated into such decision making necessarily must reflect the needs of affected stakeholders consistent with various program objectives. We intend that the study results inform that process." Contrary to that intent, in the NorthMet proceedings this uncertainty was actively dismissed. The EIS repeatedly cites the fugitive dust control plan in support of the assumption that impacts from fugitive dust would be no worse than shown by modeling.[477] The levels of control assumed by modeling and emissions factors are stated as certainties, and no uncertainty/risk analysis was done.

In addition, the NorthMet analysis omitted emissions from blasting; the modeling protocol notes "Blasting - overburden, ore, waste rock -- Not included in Class II modeling because not suitable to model with AERMOD; controlled through proper blast design."[478] However blasting emissions are generally significant. The Minnesota Regional Copper-Nickel Study estimated the range of dust emissions from blasting at 0.00015 to 0.16 pounds of particles per short ton of material blasted.[479] Based on the amount of blasting done in a typical mining operation, the total emissions were estimated between 1.5 and 1,600 metric tons per year (mtpy), with a midpoint of 100 mtpy. These levels of emissions are significant in comparison to state and federal permitting guidelines (25 and 100 tpy, respectively), and could affect the level of air deposition in areas surrounding mines.

Due to omitted sources and uncertain amounts of fugitive dust, as well as the uncertain effectiveness of control measures, the likely outcome, will likely be fugitive dust impacts that are significantly worse than predicted. This approach is unacceptable for the Rainy River-Headwaters, where failure to accurately predict air quality and deposition impacts could have substantial impacts on recreation, wilderness, ORVW waters, and a Class 1 airshed.

V. Substances used to control fugitive dust pollute water and affect vegetation

Achieving the amount of control needed to avoid impacts from fugitive dust sometimes requires the use of chemical dust suppressants, which in turn can pollute water and affect vegetation and other natural resources. Magnesium chloride and lignin sulfate are the two dust suppressants identified for use in the Maturi mine plan. Magnesium chloride has specifically been found to have deleterious effects on roadside vegetation and downstream waters.[480,481] At the Buckhorn Mine, magnesium chloride used to control dust on a haul road made its way into nearby Marias

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[477] NorthMet FEIS 5-313, 5-412, A-207, A-304.
[478] PolyMet Mining Co. (2017). MPCA Form AQDM-01, Air Quality Dispersion Modeling Protocol, AQ facility/ permit ID No. 13700345, Large Table 1.
[479] Ritchie, I., & Kreisman, P.J. (1979). *Regional Copper-Nickel Study, Vol. 3, Chap. 3: Air Resources.* Minnesota Environmental Quality Board.
[480] Goodrich, B.A., Koski, R.D., & Jacobi, W.R. (2009, Jan.). Condition of soils and vegetation along roads treated with magnesium chloride for dust suppression. *Water Air Soil Pollut 198,* 165–188. https://doi.org/10.1007/s11270-008-9835-4
[481] Goodrich, B.A., Koski, R.D., & Jacobi, W.R. (2009, Nov.). Monitoring surface water chemistry near magnesium chloride dust suppressant treated roads in Colorado. *Journal of Environmental Quality 38*, 2373-2381. doi:10.2134/jeq2009.0042.

Creek at a location on U.S. Forest Service property. Although water quality standards were not exceeded, the degradation was significant enough to require corrective action.[482]

The Buckhorn mine is unusual in that more extensive monitoring is required than is typical, and the Forest Service was thus able to identify water quality issues arising from the use of dust suppressants. It is likely that at many sites, however, these impacts are never discovered by regulators. Also, many of the impacts of dust suppressants (increased runoff due to a more impermeable surface; the presence of toxic compounds not expected to be present and thus not tested for; impacts on vegetation, macroinvertebrates, and soil) would not be identified in typical monitoring.

A 2002 EPA report[483] outlines the potential environmental impacts of the primary dust suppressants in use at that time, which included magnesium chloride and lignin sulfate. According to the report, "Potential environmental impacts include: surface and groundwater quality deterioration; soil contamination; toxicity to soil and water biota; toxicity to humans during and after application; air pollution; accumulation in soils; changes in hydrologic characteristics of the soils; and impacts on native flora and fauna populations."

Points made by the EPA report include:

- The majority of the dust suppressants created a surface that is more impermeable than the natural soil surface. This increased the runoff volume similar to that emanating from a developed land surface.
- Although Material Safety Data Sheets (MSDS's) for suppressants include the major components of the dust suppressants, they do not always include adequate details on toxic compounds that may be present and are of environmental concern. Because the vast majority of compounds used as dust suppressants are waste products from the manufacturing industry, their chemical composition is often unknown and complex and may vary widely for each batch.
- In more complex scenarios, the chemical constituents of the suppressant can react with and leach toxic components out of the soils at the application site. The issue of leaching is particularly relevant where dust suppressants are used on coalfields, landfills, and mine tailings piles, which may contain hazardous material.
- The constituents of the suppressants may be taken up by plant roots and systemically affect plants. In addition, soil microorganisms may biotransform the suppressants into benign or more toxic compounds depending on the environmental conditions on the site of application.
- It is noteworthy that dust suppressants have little efficacy at suppressing small respirable dust that have the potential to be inhaled directly into lung parenchyma and cause lung disease (Reilly *et al.*, 2003). Dust suppressants are generally used to comply with PM10 regulations and improve visibility; but could be potentially harmful since smaller dust particles (less than 10 μm) can be inhaled.

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[482] Crown Resources Corp. (2020). *AKART evaluation: Buckhorn Mine remediation water management system*.
[483] U.S. EPA (2002). *Potential Environmental Impacts of Dust Suppressants: "Avoiding Another Times Beach."* https://nepis.epa.gov/Exe/ZyPDF.cgi/P10096FY.PDF?Dockey=P10096FY.PDF

- Application of dust suppressants, especially magnesium chloride, has been associated with the browning of trees along roadways and stunted vegetation growth in forestlands.
- Dust suppressants that affect macroinvertebrates could cause a decrease in food supplies for fish. Dust suppressants that result in increased suspended solids concentration, either directly or indirectly, via erosion, can potentially degrade aquatic habitat. At the micro level, suppressants can potentially be toxic to soil and water microorganisms.
- If the soil surface is not bound together well (i.e., chlorides, lignin) or if the rain event is extreme, dust suppressant treated soil particles can be carried by overland flow into streams, rivers, and ditches. Sedimentation and uptake of soil particles could adversely affect aquatic or marine life, if sufficient numbers of treated particles have significant and mobile concentrations of hazardous compounds. Settled particles can also change the composition of the ecological community and the dominant species.

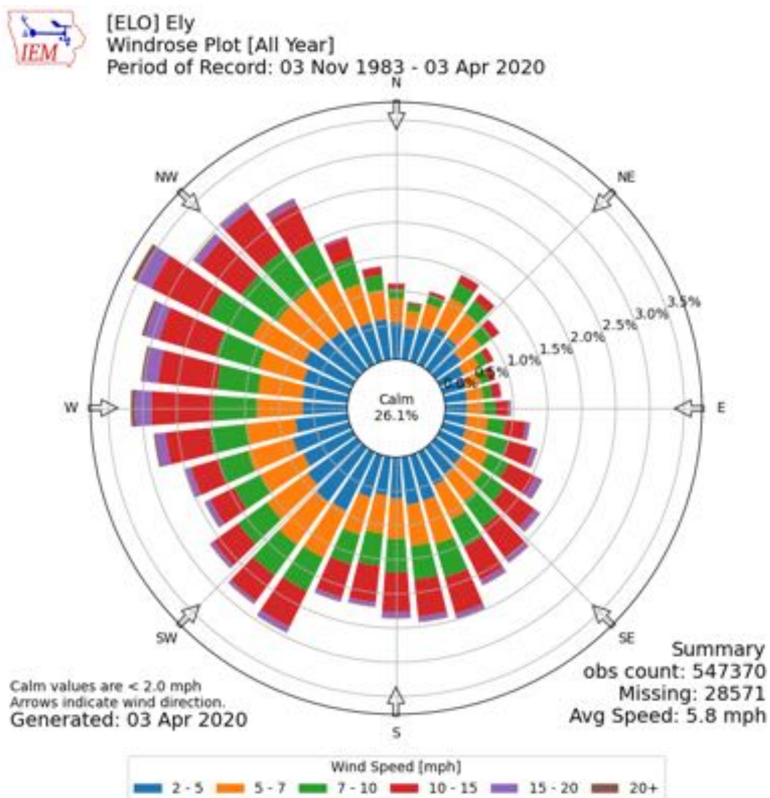
The report also includes advice from experts to avoid the use of dust suppressants in sensitive environments, near surface water, in areas with fractured rock, and in areas with a shallow water table. These factors are all present in the Rainy River-Headwaters.

VI. Pollutants from sulfide-ore copper mining in the Rainy River-Headwaters would affect waters in the BWCAW and other downwind protected areas

Any sulfide-ore copper mine in the Rainy River-Headwaters would be sufficiently close to the BWCAW, and to wetlands and streams that flow to BWCAW waters, that air emissions and fugitive dust would affect the BWCAW.

In addition to deposition into waters immediately around the mine that flow northward to the BWCAW through Fall Lake, air pollutant deposition would affect areas of the BWCAW that are not otherwise downstream of potential mining areas. The minor watersheds of August and Bald Eagle/Gabbro Lakes begin directly to the east of the Twin Metals site; the Ely area wind rose[484] indicates strong prevailing winds and occasional high winds[485] blowing directly from the proposed mine toward the BWCAW:

[484] Iowa Environmental Mesonet (2020). Weather data from Ely, Minnesota airport. Iowa State University. Retrieved Sept. 24, 2020, from https://mesonet.agron.iastate.edu/sites/locate.php?network=MN_DCP
[485] *See* U.S. EPA (2006a). Chapter. 13.2.5, Industrial wind erosion. In *AP-42, Compilation of Air Emissions Factors*. Retrieved Sept. 23, 2020, from https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0205.pdf The text points out that "erosion potential has been found to increase rapidly with increasing wind speed."



The August and Bald Eagle/Gabbro watersheds are within the distance that would likely be affected by windblown dust and other emissions at potential mine sites. Also affected would be the Harris Lake Unique Biological Area and the Keeley Creek Research Natural Area (RNA), which was set aside as a pristine example of a specific native plant community (jack pine/black spruce forest) for the purposes of research and assessment.[486]

Fugitive dust from taconite mines has been known to travel as far as ten miles.[487] It also appears that emissions from the Eagle Mine are travelling a significant distance; copper in ambient air thirteen miles from the mine site have been measured at very high levels. Although an understanding of the data is limited due to the lack of baseline monitoring, copper levels in Big Bay, Michigan are higher than in any other area in the world for which we were able to find recent studies:

[486] See Part 2, Section D.II.a. below.

[487] Zwissler, B. (2016). *Dust susceptibility at mine tailings impoundments: Thermal remote sensing for dust susceptibility characterization and biological soil crusts for dust susceptibility reduction*. [Dissertation, Michigan Technological University]. https://digitalcommons.mtu.edu/etdr/309

Location	Ambient air concentration of copper, in ng/m^3
Big Bay, Michigan[488]	24.1 – 192 (mean 108.6)
New South Wales, Australia[489]	2.4 – 28 (mean 8.2)
Switzerland, rural to Bern city center[490]	5-65 (values are means from 4 locations)
Netherlands, rural to Amsterdam street[491]	5-30 (values are means from 4 locations)
Elazig and rural Turkey[492]	12-75 (mean values not available)
Gajraula, India[493]	4-138 (mean 45)

These results are particularly striking because concentrations of other metals in Big Bay were about the same or lower than those in other parts of the world. Other than industrial activity, the primary source of copper in air emissions is from vehicle brakes, and rural areas generally have much lower copper concentrations in ambient air than cities.

The proposed Maturi mine site is less than ten miles from the BWCAW to the east. The Keeley Creek and Harris Lake protected sites are just one to two miles downwind of likely fugitive dust sources. It was understood at the time of the Regional Copper-Nickel Study that the potential for wind-blown emissions might mean that mining operations could not be located close to the BWCAW. The report states, "Because of the proximity of the BWCAW to potential copper-nickel development sites, some development sites may be prohibited because air emissions would exceed the strict limitations of a Class I region."[494] For the prototype mine used in the study, modeling found that "Class I 24-hour PSD increments may be exceeded up to 10 kilometers away from industrial activity in some directions." While this does not explicitly relate to air deposition, it does indicate that air emissions could result in impacts for an extensive distance downwind of mining operations.

Blowing dust and other emissions would conflict with existing use of the Withdrawal Area as well. The unspoiled natural environment is a primary reason why people recreate here; the same can be said regarding residents' reasons for living here.

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488 Depa, M., & Williams, K. (2014). *Methods for health effects screening of Big Bay metals air monitoring data.* Michigan Dept. of Environmental Quality.
489 New South Wales Dept. of Environment and Conservation (2003). *Ambient Air Quality Research Project (1996-2001), Internal working paper No. 4, Ambient concentrations of heavy metals in NSW*.
490 Denier van der Gon, H.A.C. et al. (2013). The policy relevance of wear emissions from road transport, now and in the future—An international workshop report and consensus statement. *Journal of the Air & Waste Management Association, 63,* 136-149.
491 *Id.*
492 Yaman, M. & Erel, E. (2013). Determination of Fe, Zn and Cu in ambient air by combining pre-concentration methods and FAAS. *Int. J. Environ. Res., 7,* 989-994.
493 Kamar, A., et al. (2019). Chemical analysis of trace metal contamination in the air of industrial area of Gajraula (U.P.), India. *Journal of King Saud University – Science 32,* 1106–1110.
494 Ashbrook, P. (1979).

C. The proposed Withdrawal is essential to prevent degradation of aquatic resources in the Withdrawal Area and protected areas downstream and downwind of sulfide-ore copper mining

The Withdrawal Area and the protected areas downstream and downwind are defined by their extremely high-quality water, fisheries, and other aquatic resources. Absent the Withdrawal, sulfide-ore copper mining in the Rainy River-Headwaters would result in significant water- and airborne sources of contamination to the MPA, BWCAW, and other protected areas. The resulting water contamination would degrade ecosystem health, harm fisheries and consumers of fish, damage wild rice, and have other harmful effects on aquatic and terrestrial organisms and systems.

I. The Withdrawal Area is of high value for aquatic resources

The high quality and vast amount of water in the Withdrawal Area and the BWCAW supports correspondingly high aquatic resources. Environmental review should address the impacts and risks to these resources that would likely occur from sulfide-ore copper mining in the watershed, and the protection for these resources that the proposed Withdrawal would afford.

The water resources of the Rainy River-Headwaters, including the Withdrawal Area, include more than a thousand miles of major streams and rivers, and a vast number of lakes. Voyageurs National Park just downstream from the Superior National Forest holds 84,000 acres of lake area. The streams, rivers, and lakes support sport fisheries of national and international importance. These aquatic resources are spread over a several-million-plus acre naturally-vegetated landscape that helps ensure the waters remain clean.

The Withdrawal Area alone contains 535.8 miles of streams, including 182.6 miles of designated trout streams, and 36.8 miles of designated trout stream protected tributaries. The Withdrawal Area also holds 171.1 miles of river, 45,596.8 acres of lakes and ponds, approximately 220,000 acres of wetlands.[495]

The high-quality water in the Rainy River-Headwaters[496] is due to its almost entirely (>99%) undeveloped forest and wetland landscape. [497] The water has intrinsic value, as well as the value of the ecosystem that it supports – tremendous fisheries, wild rice and other vegetation, aquatic and terrestrial life, and ecosystems – and its use for drinking water.

a. Fisheries

The Withdrawal Area, BWCAW and VNP are home to a wide diversity of native fish, including nearly 40% of Minnesota's approximately 150 native fish species, and nearly 55% of Minnesota's approximately 25 native fish families. Genetic strains and cold-water fish assemblages are supported in the BWCAW and VNP, and about 50 lakes there have been

[495] Wolfe, J. (2022, January 5). Wetlands & Trout Streams in the Withdrawal Area [Map]. Northeastern Minnesotans for Wilderness.
[496] MPCA (2021, Aug). *Draft Rainy River-Headwaters Watershed Restoration and Protection Strategy Report*.
[497] MPCA (2017, June). *Rainy River-Headwaters Watershed Monitoring and Assessment Report*.

identified as refuge lakes cold-water species such as cisco, lake whitefish and lake trout. [498]

Fishes in the BWCAW and VNP are an integral component of a larger ecological system, and they provide a diversity of ecosystem services. Peer-reviewed and published scientific papers describe fish as ecological engineers that regulate nutrients and food webs, and contribute to the resiliency of aquatic systems.[499] These qualities are demonstrated by trophic cascades, i.e., the process whereby changes in fish abundance cascade through a food chain to affect water quality. Fish provide important links to terrestrial ecosystems, and several species in the Withdrawal Area are essential to the life cycle of state-listed freshwater mussels that also occur in the region, such as the threatened flutedshell, *Lasmigona costata*.[500] Fish in the Withdrawal Area and the BWCAW and VNP perform important ecosystem services by serving as ecological indicators and records of information, and by providing nutrition to a host of aquatic and terrestrial species, including humans, both as subsistence and as recreation.

b. The amount and distribution of wild rice in the Withdrawal Area

Many waters within the Withdrawal Area and other nearby (downstream, near downwind) SNF lands in the Rainy River Basin are wild rice waters.[501] These include but are not limited to: the South Kawishiwi River, Stony River, Birch Lake, South Farm Lake, and the White Iron of Lakes (White Iron, Farm, S. Farm, Garden), and Fall Lake (which are all on the flow-path downstream from Twin Metals' proposed Maturi Deposit mine). A sampling of other nearby wild rice lakes and rivers includes Stony River, Harris Lake, Denley Lake, Kangas Lake, Blueberry Lake, Harris Lake, and August Lake; and also Bald Eagle, Gabbro, and Little Gabbro Lakes in the BWCAW.

Wild rice is an important emergent aquatic plant for wildlife. Stands of wild rice in the Withdrawal Area waters contribute to shallow water aquatic vegetative structure and shade, two characteristics of sheltering, feeding, and nursery habitat for minnows and larger fish. Wild rice stands absorb and reduce the energy of wave action, suppressing shore erosion and the re-suspension of bottom sediments, and maintaining water clarity. Wild rice produces a nutritious late summer-to-fall grain crop of longstanding importance[502] to people and wildlife alike. Wild rice that has higher protein content than most cereal grains. The nutritional value and timing of production make wild rice an important food for fish and wildlife, particularly migratory waterfowl.

The low sulfate concentrations that have existed and continue to exist in the waters of the Withdrawal Area and elsewhere in the Rainy River Basin are critical to the maintenance of wild

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[498] Venturelli, P., & Vondracek, B. (2017). *The fish and fisheries of the Boundary Waters Canoe Area Wilderness and Voyageurs National Park, and their vulnerability to copper sulfide mining.* Prepared for Campaign to Save the Boundary Waters.
[499] *Id.*
[500] *Id.*
[501] Disbrow, J., & Norton, M. (2021). Wild Rice in the Rainy River Basin. [Map]. Northeastern Minnesotans for Wilderness.
[502] 1854 Treaty Authority (n.d.). *Wild Rice.* Retrieved December 31, 2021 from https://www.1854treatyauthority.org/wild-rice/wild-rice.html

rice stands,[503] including wild rice stands in the White Iron Chain of Lakes.[504] An increase in sulfate concentrations, whether in surface waters or in groundwater that intercepts surface waters, would diminish wild rice stands or eradicate wild rice altogether from the affected waters.

It is likely, however, that sulfate levels in Birch Lake have already affected wild rice stand health and distribution, as the water quality standard of 10 mg/L is regularly exceeded in some locations.[505,506] In addition, MPCA has determined that the standard is not low enough to protect wild rice stands in many lakes. MPCA recently undertook an extensive study of the interactions of sulfate, iron, and organic carbon as they impact wild rice propagation.[507] Although the proposed site-specific, equation-based standard that came out of that study was struck down[508] and the 10 mg/L standard remains in effect, the science of the MPCA study remains valid and important.[509] That science indicates that for many waters, wild rice stands will be impacted by sulfate at levels far below 10 mg/L.[510] For some waters, *any* addition of sulfate will negatively affect wild rice propagation. The Forest Service should not assume that wild rice will be protected if the 10 mg/L sulfate standard is met, but rather should consider wild rice lakes in the Withdrawal Area to be vulnerable to any increase in sulfate, and that any increase in sulfate above background levels and above current levels to represent a degradation of water quality and other important culturally and ecologically resources.

While other aquatic plants have not been studied as intensively as wild rice, they may also be affected in similar ways by sulfate additions. The wild rice standard serves as protection not just for wild rice but for aquatic plant communities.

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[503] Pastor, J., Dewey, B., Johnson, N.W., Swain, E.B., Monson, P., Peters, E.B., & Myrbo, A. (2017). Effects of sulfate and sulfide on the life cycle of Zizania palustris in hydroponic and mesocosm experiments. *Ecological Applications*, *27*, 321-336. DOI: 10.1002/eap.1452.
[504] Disbrow, J., & Norton, M. (2021).
[505] Pugh, L. (2021). 2020-2021 Sulfate Sampling Effort for Birch Lake (69-0003-00). Northeastern Minnesotans for Wilderness.
[506] Brezonik, P.L. (2021, Sept. 20). Letter to Maccabee, P., WaterLegacy, and Norton, M., Northeastern Minnesotans for Wilderness.
[507] Bael, D., Blaha, G., Engelking, P., Kaufenberg, E., Kyser, S., Lotthammer, S., Monson, P., Neuschler, C., Peters, E., Shore, M., & Swain, E. (2017). MPCA Final Technical Support Document: Refinements to Minnesota's Sulfate Water Quality Standard to Protect Wild Rice. Minn. Pollution Control Agency. https://www.pca.state.mn.us/sites/default/files/wq-rule4-15n.pdf
[508] Minn. Office of Admin. Hearings (2018, April 12). *In the Matter of the Proposed Rules of the Pollution Control Agency Amending the Sulfate Water Quality Standard Applicable to Wild Rice and Identification of Wild Rice Rivers, Minnesota Rules parts 7050.0130, 7050.0220, 7050.0224, 7050.0470, 7050.0471, 7053.0135, 7053.0205 and 7053.0406*, Chief Administrative Law Judge's Order. https://mn.gov/oah/assets/9003-34519-pca-sulfate-water-quality-wild-rice-rules-chief-judge-reconsideration-order_tcm19-335811.pdf.
[509] An important caveat is that the equation did not incorporate the findings of a scientific study indicating that high levels of iron may negatively impact wild rice in other ways, despite the fact that the proposed equation was premised in part on findings that wild rice is better able to propagate in high-sulfide conditions if iron is also present. This is one of the reasons the proposed rule was struck down.
[510] Bael, D., et al. (2017).

c. Safe drinking water for homes, businesses, and visitors

Protecting the extremely high quality of the Withdrawal Area's aquatic resources is of enormous importance to the quality of life, health, and safety of people who reside and spend time in the area. Most of the people who live in and visit the Withdrawal Area and the BWCAW depend upon the clean water resources of lake water or shallow wells for drinking, cooking, and bathing. Wells serve about half the population of Lake County, and most of those wells are shallow and can be readily contaminated.[511] Paddlers and campers in the Withdrawal Area depend upon lake water for drinking and cooking. Many popular waters for paddling and camping – such as S. Kawishiwi River and Birch, White Iron, Farm, Garden, Fall, Newton, and Basswood Lakes – are along the paths of pollution from possible sulfide-ore copper mining in the Withdrawal Area. Surface waters test as clean and safe, with any pollutants well below federal drinking water standards in all measured categories.[512,513] Pollution of these waters, whether originating in surface or groundwater, would make its way into the waters people use for drinking, cooking, bathing and recreating, and potentially pose a risk to human health.[514]

d. Importance to terrestrial wildlife and ecosystems

A number of terrestrial plant and animal species have an aquatic stage in their life history, depend for a share of their diet on aquatic plant or animal prey items, or otherwise depend on organisms whose own life histories have an essential aquatic component.[515,516] For example, moose – an iconic and prized species to see in the SNF, including in the Withdrawal Area and the BWCAW – depend on aquatic plant matter to supply a substantial share of their sodium requirements.[517] A number of other iconic species, such as loons, bald eagles, osprey, river otter, and mink also are sought-after by wildlife watchers in the SNF, including in the Withdrawal Area and the BWCAW. These species consume and to varying degrees depend on fish for food. Many bat and bird species consume insects whose development involves aquatic larval stages, or which consume other insects whose development has an aquatic phase. In short, harm to the aquatic environment would in turn result in harm to terrestrial portions of the environment.[518]

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[511] Baker, L.A. (2013). *Potential ecological impacts of the Twin Metals Mine.* Prepared for Northeastern Minnesotans for Wilderness.
[512] Geerts, S.M. (2017). *2013 Project abstract for the period ending June 30, 2017*. Project Title: Assessment of natural copper-nickel bedrocks on water quality.
[513] Anderson, J., Thompson, D., Valley, R., & Butcher, J. (2010, January). *Sentinel Lake Assessment Report, White Iron Lake (69-0004) Saint Louis County, Minnesota.* Minnesota Pollution Control Agency & Minnesota DNR.
[514] Myers, T. (2015). Technical Memorandum- Potential Metals Mining and the Voyageurs National Park, Risk Assessment for Upstream Metals Mining.
[515] Frelich, L.E. (2014). *Forest and terrestrial ecosystem impacts of mining.*
[516] Frelich, L.E. (2019). Terrestrial ecosystem impacts of sulfide mining- Scope of issues for the Boundary Waters Canoe Area Wilderness, Minnesota, USA. *Forests, 10,* 47. doi:10.3390/f10090747
[517] Powell, R.A. (2017). *Mammals and mining in sulfur-bearing rock formations in northeastern Minnesota.* Prepared for Northeastern Minnesotans for Wilderness.
[518] *See* Section 2.D.

II. Mining in the watershed would affect fish and other aquatic life

Venturelli & Vondracek (2017)[519] and the formal position paper adopted by the American Fisheries Society[520] detail the ways in which fish species and regional fisheries are negatively affected by the pollution that follows the arrival of mining in a watershed. In short, fish are contaminated with metals and harmed by other mining pollution, afflicted with various diseases, and reduced in population size and extent; and fisheries are impoverished as sensitive species are extirpated from polluted watersheds. Industrial water consumption that further reduces low- flow conditions also can harm fisheries. Mining-caused changes in water chemistry can harm a host of other aquatic organisms including aquatic vegetation and invertebrates, effects which in turn can prompt other negative effects. Additions of acid and acid-dissociation compounds, especially sulfate, have a range of harmful effects on the aquatic systems and the larger environment.

a. Reduced low-flows and water quality changes can harm fish

Mining development invariably involves industrial water withdrawals, which can reduce flow volumes. Reduced water quantity may harm fish, especially during times of low flow. Low flows are stressful for fish because water temperatures rise and dissolved oxygen levels fall. Absent the proposed Withdrawal, reduced flows could result from surface water and groundwater withdrawals for ore processing, mine dewatering, surface water diversions, and hydrographic foreshortening due to vegetation clearing. In addition, ponding of contact water, evaporative losses from ponds, and disposal of leachate pumpback or filtrate residues would all reduce available surface water quantity.

Increased development in the watershed at the scale necessary for mining would also degrade water quality through increased delivery of total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN).[521] Mining development also consistently results in significant increases in total dissolved solids (TDS) and specific conductance (SC),[522] which as discussed below can significantly harm aquatic life.

b. Acidification and heavy metals can significantly harm aquatic organisms and fish species diversity and numbers

Pollutants that are commonly discharged to local waters from sulfide-ore copper mining impact aquatic organisms and fish species. According to a 2008 literature review for the U.S. Fish & Wildlife Service:

> Fisheries have been impaired world-wide by releases of AMD from mining areas. . . . . Evidence from literature and field observations suggests that permitting large scale surface mining in sulfide-hosted rock with the expectation that no degradation of

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[519] Venturelli, P., & Vondracek, B. (2017).
[520] Hughes, R.M., Amezcua, F., Chambers, D.M., Daniel, W.M., Franks, J.S., Franzin, W., MacDonald, D., Merriam, E., Neall, G., dos Santos Pompeu, P., Reynolds, L., & Woody, C.A. (2016). AFS Position Paper and Policy on Mining and Fossil Fuel Extraction. *Fisheries 41,* 12-15. DOI: 10.1080/03632415.2016.1121742.
[521] MPCA (2021, Aug).
[522] Although there is not an exact correlation between TDS and specific conductivity, they refer to the same pollutants and are used interchangeably here.

> surface water will result due to acid generation imparts a substantial and unquantifiable risk to water quality and fisheries.[523]

Mine drainage from Duluth Complex mines would likely have decreased pH,[524] significantly increased metals and sulfate concentrations, and increased TDS/ SC. Low pH conditions increase the mobilization of metals from mining waste materials, but some metals are also readily mobilized in basic and circumneutral conditions. Acidic or not, mine drainage would deliver sulfate and heavy metals to groundwater and surface waters, increasing TDS and exposure of aquatic invertebrates, fish, and certain terrestrial organisms to the heavy metals and their toxic effects.

Some metals bioaccumulate up through the trophic levels in food webs, with the highest concentrations typically found in top predators such as sport fish, and the species and individuals that consume the most fish. A 1991 large scale study in a 130-mile river system (Blackfoot River, Montana) found that some solute and particulate contaminants were transported through the river system and an extensive marsh system, resulting in heavy metals contamination of the food web downstream. Of the heavy metals present downstream (cadmium, zinc, copper, arsenic, and nickel), cadmium accumulated most in the food web, followed by zinc, copper, arsenic and nickel. Stream sediment contamination coincided with diminished benthic communities lower fish populations.[525]

Peer-reviewed, published scientific literature indicates that mining pollution can cause long-term declines in fish abundance, species and genetic diversity, and may facilitate the establishment of invasive species. A survey of lakes in Canada near mines demonstrated the effect acidification, heavy metals, and other pollution could have on fish communities and diversity. In six of the most acidic lakes, there were no fish populations at all. Top fish predators, such as walleye and yellow perch, were only found in those lakes farthest from the source of pollution. High arsenic levels from mine runoff impact fish communities as well. The study found a direct relationship between number of fish species in a lake and that lake's distance from the pollution source.[526] Two studies that examined the effects of a gold mine tailings spill in Canada on walleye found significant impacts on the walleye population. Research determined that a high mortality of walleye eggs in the polluted areas was most likely due to high concentrations of copper and zinc, along with possible hypoxia from the settlement of tailings.[527] Fish near the reach of the spill

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[523] Jennings, S.R., Neuman, D.R. & Blicker, P.S. (2008). *Acid mine drainage and effects on fish health and ecology- A review*. Reclamation Research Group. Prepared for U.S. Fish and Wildlife Service, Anchorage Fish and Wildlife Field Office.

[524] U.S. EPA (1994, Dec.). *Technical Document: Acid Mine Drainage Prediction*. (EPA530-R-94-036).

[525] Moore, J.N., Luoma, S.N., & Peters, D. (1991). Downstream effects of mine effluent on an intermontane riparian system. *Canadian Journal of Fisheries and Aquatic Sciences, 48,* 222–32.

[526] Somers, K.M., & Harvey H.H. (1984). Alteration of fish communities in lakes stressed by acid deposition and heavy metals near Wawa, Ontario. *Canadian Journal of Fisheries and Aquatic Sciences*. *41,* 20–29. doi:10.1139/f84-002.

[527] Leis, A.L., & Fox, M.G. (1994). Effect of mine tailings on the in situ survival of walleye (*Stizostedion vitreum*) eggs in a Northern Ontario river. *Écoscience 1,* 215–22.

were significantly smaller than those in unaffected water, ate less, and were dying or leaving the area at higher rates, likely because of the die-off of smaller fish on which walleye feed.[528]

A study published in 2015 examined the effects of mining on fish at a large spatial scale, and showed that mining had a more pronounced and consistent impact on fish assemblages than any other human activity that had been assessed over a large area, including agriculture and urban land use.[529] Mining-related increases in SC would have a pronounced effect in the Withdrawal Area due to its exceptionally low background levels of SC, to which aquatic species in the area are adapted.[530,531] Environmental review should consider potential damage to aquatic resources from sulfide-ore copper mining-caused SC pollution, particularly the harm to macroinvertebrates and fish, and the degradation of stream health.

Numerous studies document the impacts of acid mine drainage on aquatic insect populations. The diversity and health of macroinvertebrate populations is a strong indicator of overall stream health. A significant number of macroinvertebrate species, including dragonflies, caddis flies, and mayflies, have life histories with an essential aquatic component and play important roles in aquatic ecosystems. One critical role is as food for fish. A study of macroinvertebrate communities at different points in a stream affected by AMD pollution showed a loss of diversity in habitats closer to sources of AMD.[532]

As early as 1944, scientists and government officials understood that the normal biological activity of a stream is altered and slowed when contaminated by AMD.[533] Direct declines in the diversity and density of aquatic insect populations have been recorded,[534,535,536] with aquatic invertebrate species Ephemeroptera and Plecoptera and some Odonata most affected.[537,538] Increasing acidity of the water can also result in a lower percentage emergence for aquatic

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528 Leis, A.L., & Fox, M.G. (1996). Feeding, growth, and habitat associations of young-of-year walleye (*Stizostedion vitreum*) in a river affected by a mine tailings spill. *Canadian Journal of Fisheries and Aquatic Sciences 53,* 2408–17.

529 Daniel, W.M., Infante, D.M., Hughes, R.M., Tsang, Y.P., Esselman, P.C., Wieferich, D., Herreman, K., Cooper, A.R., Wang, L., & Taylor, W.W. (2015). Characterizing coal and mineral mines as a regional source of stress to stream fish assemblages. *Ecological Indicators*, *50,* 50–61.

530 Johnson, B.L., & Johnson, M.K. (2015). *An evaluation of a field-based aquatic life benchmark for specific conductance in northeast Minnesota.* Prepared for WaterLegacy.

531 Cormier, S.M. (2016). *Scientific Review of B.L. Johnson and M.K. Johnson's, "An evaluation of a field-based aquatic benchmark for specific conductance in northeast Minnesota" (November 2015)*. U.S. EPA.

532 Dills, G., & Rogers, D.T. (1974). Macroinvertebrate community structure as an indicator of acid mine pollution. *Environmental Pollution, 6,* 239–62.

533 Roback, S.S., & Richardson, J.W. (1969). The effects of acid mine drainage on aquatic insects. *Proceedings of the Academy of Natural Sciences of Philadelphia 121.* 91-107.

534 Maret, T.R, Cain, D.J., MacCoy, D.E., & Short, T.M. (2003) Response of benthic invertebrate assemblages to metal exposure and bioaccumulation associated with hard-rock mining in northwestern streams, USA. *J. N. Am. Benthol. Soc., 22,* 598–620.

535 Tomkiewicz, S., & Dunson, W. (1977). Aquatic insect diversity and biomass in a stream marginally polluted by acid strip mine drainage. *Water Research*, *11,* 397–402. https://doi.org/10.1016/0043- 1354(77)90029-x

536 Hoiland, W.K. (1992). *Recovery of macroinvertebrate communities from metal pollution in the South Fork and mainstem in the Coeur D'Alene River, Idaho 1968-1991*. [Master's Thesis, University of Idaho]. Idaho Waters Digital Library, Digital Initiatives, University of Idaho Library.

537 Roback, S.S., & Richardson, J.W. (1969).

538 Lind, D., Halpern, T. & Johnson, M.D. (1978). *Regional Copper-Nickel Study: The toxicity of heavy metals, beneficiation, reagents and hydrogen ion to aquatic organisms.* Minnesota Environmental Quality Board.

insects, with emergence lowering to 50% within water with a pH range of 4.0 to 5.9.[539] In addition, a lower acidic range along with other decreases in chemical parameters can increase copper and nickel toxicity to benthic organisms.[540] Declines via heavy metal toxicity, water acidification, or direct exposure to AMD can be drastic enough to completely extirpate these aquatic species from local water systems.[541] Even without the known presence of AMD, total abundance and species richness of aquatic insects is reportedly lower in hard-rock mining areas.[542] Loss of stream diversity can persist for decades. One study found cadmium and zinc levels significantly correlated with a smaller percentage of plecopterans 70 years post-mining.[543]

Changes in the distribution or abundance of one species of aquatic arthropod can result in community structure changes that have resounding ecosystem effects. For example: Ephemerella (Mayflies) are important members of a healthy ecosystem because they function as detritus grazers, helping to prevent a build-up of biomass and algae. Ephemerella also currently face nationwide population declines, with a 50% decrease in emergence events along the Upper Mississippi River and Western Lake Erie Basin.[544] Population loss of Ephemerella due to mining operations would contribute both to the nationwide decline and to a decline in important ecosystem functions that maintain the nutrient cycling and stability of the local environment.[545] The decline of mayflies, Plecoptera (stoneflies), or other aquatic detritivores would increase the build-up of organic matter within streams and prevent the creation of smaller sized particles of detritus, reducing the resources available for other invertebrates like suspension feeders that utilize these smaller pieces.[546]

As mayflies demonstrate, leaf litter processing occurs through both abiotic and biotic factors, including through grazing and shredding by macroinvertebrates. This is an extremely important ecosystem input, as 60-70% of the annual detritus particulates are biologically utilized by stream macro and microorganisms.[547] Disruptions to the processing of organic detritus have been observed in direct response to AMD and increased concentrations of heavy metals. In one study, a control stream had a processing rate of detritus twice as fast when compared to a stream below an active mining operation. It was hypothesized that this was in response to the lower pH present within the impacted stream, as well as higher quantities of iron, magnesium, and sulfate that

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[539] Bell, H.L. (1971). Effect of low pH on the survival and emergence of aquatic insects. *Water Research, 5,* 313-319.
[540] Lind, et al. (1978).
[541] Roback, S.S., & Richardson, J.W. (1969).
[542] Maret, et al. (2003).
[543] Lefcort, H., Vancura, J. & Lider, E.L. (2010). 75 years after mining ends stream insect diversity is still affected by heavy metals. *Ecotoxicology, 19,* 1416-1425. DOI 10.1007/s10646-010-0526-8.
[544] Stepanian, P.M., Entrekin, S.A., Wainwright, C.E., Mirkovic, D., Tank, J.L., & Kelly, J.F. (2019). Declines in an abundant aquatic insect, the burrowing mayfly, across major North American waterways. *Proceedings of the National Academy of Sciences, 117,* 2987-2992. doi:10.1073/pnas.1913598117/-/DCSupplemental.
[545] Santonja, M., Pellan, L., & Piscart, C. (2017). Macroinvertebrate identity mediates the effects of litter quality and microbial conditioning on leaf litter recycling in temperate streams. *Ecology and Evolution, 8,* 2542-2553. DOI: 10.1002/ece3.3790.
[546] Covich, A.P., Palmer, M.A., & Crowl, T.A. (1999). The role of benthic invertebrate species in freshwater ecosystems: Zoobenthic species influence energy flows and nutrient cycling. *BioScience, 49*, 119-127. https://doi.org/10.2307/1313537
[547] Anderson, N.H., & Sedell, J.R. (1979). Detritus processing by macroinvertebrates in stream ecosystems. *Annual Review of Entomology, 24,* 351-71.

produced environmental conditions that reduced the abundance and diversity of insects.[548] A meta-analysis of existing data regarding the effects of heavy metal contamination on the decomposition of terrestrial litter in running waters also concluded that copper and zinc concentrations significantly inhibited leaf litter decomposition.[549] In addition to concentration of heavy metals, increased sediment within leaf packs and suspended sediment appeared to impede processing efforts. This increased sediment load occurred even after the closure of local mining projects, continuing to impact leaf-litter insect fauna and prevent ecosystem recovery. The processing of leaf litter and other types of detritus is an enormously consequential operation that enables the cycling of carbon and nutrients throughout an ecosystem and therefore enables energy pathways that support much of the biological production within local systems.

In addition to significant implications for the ecosystem services that aquatic arthropods provide, accumulation of heavy metals within these species results in bio-transference into upper trophic levels through the predation of contaminated insects[550] and other aquatic invertebrates. This trophic transfer can biomagnify toxins, leading to increasing population health impacts for many local species,[551] including a number of sensitive mammals and birds within the Superior National Forest. For example, northern long-eared bats, which are listed as threatened on the U.S. Endangered Species List, often prey on insects that emerge from aquatic larvae.

Some important aquatic food plants, such as wild rice, sequester heavy metals, affecting both humans and wildlife consumers. A study done on wild rice in Northern Wisconsin found that concentrations of arsenic and lead were elevated within the plants.[552]

The unique bogs, wetlands, and water systems in the Rainy River-Headwaters are home to dozens of resident bird species and are utilized as stopover places for many migratory birds. Increasing the concentrations of methylmercury, selenium, and other heavy metals within these water systems could have major impacts on the reproductive capacities of avian piscivores.

The Gold King Mine in Silverton, Colorado is one example of a how an accidental release of toxic wastewater into the watershed of an important ecosystem can have devastating impacts on local wildlife. Slow leakage of AMD as well as a major breach event caused insect populations and species richness to "plummet," with impacts resonating throughout the local environment long after the closure of mining activities.[553]

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[548] Scheiring, J.F. (1993). Effects of surface-mine drainage on leaf litter insect communities and detritus processing in headwater streams. *Journal of the Kansas Entomological Society, 66,* 31-40.
[549] Ferreira, V., Koricheva, J., Duarte, S., Niyogi, D.K., & Guerold, F. (2016). Effects of anthropogenic heavy metal contamination on litter decomposition in streams – A meta-analysis. *Environmental Pollution, 210.* 261-270.
[550] Dumas, J., & Hare, L. (2008). The internal distribution of nickel and thallium in two freshwater invertebrates and its relevance to trophic transfer. *Environmental Science & Technology, 42,* 5144-5149.
[551] Tovar-Sánchez, E., Hernández-Plata, I., Martínez, M. S., Valencia-Cuevas, L., & Galante, P. M. (2018). Heavy metal pollution as a biodiversity threat. In Saleh, H.E.M., & Aglan, R.F. (Eds.), *Heavy metals.* Intech Open. https://doi.org/10.5772/intechopen.74052
[552] Bennett, J., Coleman, J., Chiriboga, E., & Waller, D. (2000). Heavy metals in wild rice from Northern Wisconsin. *Science of The Total Environment, 246,* 261-269.
[553] Olivarius-Mcallister, C. (2014, April 21). Silverton flirting with Superfund? *Durango Herald*. https://www.durangoherald.com/articles/silverton-flirting-with-superfund/

c. Sulfide-ore copper mining-caused harm to aquatic macroinvertebrates, small fish, and vegetation would harm sport fish and ecosystem health

Sport fisheries and aquatic ecosystem health would suffer from the bioaccumulation of metals and their effects on fish, as well as from the reduction in macroinvertebrate abundance and species richness, and the diminution of wild rice stand coverage and density. Since small fish consume macroinvertebrates and large fish consume macroinvertebrates and smaller fish, decline in macroinvertebrate abundance and species richness would reduce overall stream productivity, stability, and health. To the extent that sport fish survive in impaired waters, they could expect to be nutritionally challenged and to have higher metals loads[554] and reduced body mass, fitness, and reproductive success compared with fish in unimpaired waters.[555] Reduced species richness, reduced abundance, and higher levels of environmental pollutants such as SC, are hallmarks of significant biological degradation.[556,557]

d. Elevated levels of sulfate would likely affect wild rice

In the western half of Birch Lake where sulfate concentrations consistently exceeded 10 mg/L in 2021,[558] large amounts of sulfate are released from lands disturbed by mining. Surveys of wild rice stands by mining company consultants suggest that sulfate has impacted wild rice in Birch Lake; the western half of the lake has very few large and dense wild rice stands (except in areas like Birch River, which are unaffected by mining discharge), while the eastern end of the lake, where sulfate concentrations average between 6 and 8 mg/L, has many significant wild rice stands in many bays, though none so dense and large as in Birch River bay.

Environmental review should address the near certainty that new mining, particularly sulfide-ore copper mining, in the Rainy River-Headwaters would result in substantially increased loading of sulfate and sulfate concentrations in area waters, and the consequences for water quality, wild rice, and ecosystem health.

e. Elevated levels of sulfate would likely contribute to releases of nitrogen and phosphorous from sediments

Environmental review should address the potential that increases in sulfate loading from sulfide-ore copper mining would contribute to eutrophication in the lakes downstream and downwind from mining operations. Sulfate additions to low-sulfate waters with largely anaerobic sediments increases the metabolism of anaerobic bacteria, causing an acceleration in bacterial decomposition of organic sediments and accelerated, increased release of phosphorus, nitrogen, dissolved organic carbon, and mercury into the water column. The increased flux of nutrients as a result of sulfate additions could cause "a wholesale change in trophic conditions in what are

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554 WaterLegacy & Johnson, B. (2011, March 10). Letter to MPCA Re: Dunka Mine (Attachment D, MPCA (1985, July 26). Office memo from Carri Lohse to Mark D.C. Schmitt regarding Birch Lake Fish Tissue Data).
555 Venturelli, P., & Vondracek, B. (2017).
556 Johnson, B.L., & Johnson, M.K. (2015).
557 Cormier, S.M. (2016).
558 See Part 2, Section A.II.c.4. above.

otherwise among the most pristine waters of the U.S.[559] Climate change is already contributing to eutrophication, and would be compounded by the effects of sulfate additions. Consequences could include greater abundance of algae, decreased water clarity, and increased biological oxygen demand (BOD) in affected waters.[560,561] Increased BOD results in lower dissolved oxygen levels, and increased chronic and acute hypoxic stress in sensitive species. The end result could be the loss of fish species like cisco, whitefish and lake trout from some lakes.[562,563]

f. Elevated levels of sulfate would likely contribute to the establishment and spread of aquatic invasive species

The Forest Service should note the potential of mining-related increased sulfide concentrations contributing not only to displacement of wild rice, but also establishment and spread of aquatic invasive species in the Withdrawal Area. Phragmites (*Phragmites australis*) and hybrid cattails (*Typha* spp.), which are tolerant of high sulfide concentrations in aquatic sediment, may also be aided by sulfate's effect of increasing the flux of nutrients from organic sediments.[564,565]

g. Increased mercury and sulfate releases will increase methylmercury in fish tissue

As explained in Part 2, Section A.II.g. above, scraping and stockpiling glacial till, soils, and peat in the course of land-clearing for mining can release significant amounts of mercury, which makes its way to surface waters through runoff or groundwater transport. High mercury in fish tissue is a ubiquitous problem around the world, but is particularly pronounced in northern Minnesota. Mercury bioaccumulates within aquatic life forms, with the concentration increasing exponentially with each step up the food-chain.[566]

Under the auspices of the Great Lakes Initiative in the 1990's, the U.S. EPA undertook a review and assessment to determine what level of mercury in surface waters of Great Lakes region would be safe for mammalian and avian wildlife, and set that level at 1.3 ng/L.[567] This level was

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[559] Engstrom, D.R. (2017, August 11). Comment to U.S. Forest Service re: Re: Northern Minnesota Federal Mineral Withdrawal EIS #50938.
[560] Heiskary, S.& Markus, H. (2001). Establishing relationships among nutrient concentrations, phytoplankton abundance, and biochemical oxygen demand in Minnesota, USA, rivers. *J. Lake and Reservoir Management, 17,* 251-262.
[561] Baker, L.A. (2013).
[562] St. Anthony Falls Laboratory (n.d.). Will lake warming in Minnesota drive cold-water fish to extinction? University of Minnesota. Retrieved Jan. 8, 2022, from https://cse.umn.edu/safl/news/will-lake-warming-minnesota-drive-cold-water-fish-extinction
[563] Venturelli, P., & Vondracek, V. (2017).
[564] Lamers, P.M., Govers, L.L., Janssen, I.C.J.M., Geurts, J.J.M., Van der Welle, M.E.W., Van Katwijk, M.M., Van der Heide, T., Roelofs, J.G.M., & Smolders, A.J.P. (2013). Sulfide as a soil phytotoxin - a review. *Frontiers in Plant Science*, *4*, 268. doi:10.3389/fpls.2013.00268.
[565] International Lake of the Woods Basin Water Quality Plan of Study Team (2014, Nov.). *International Lake of the Woods basin water quality plan of study covering the Rainy Lake of the Woods watershed*, p. 85.
[566] Mason, R.P., Laporte, J.M. & Andres, S. (2000). Factors controlling the bioaccumulation of mercury, methylmercury, arsenic, selenium, and cadmium by freshwater invertebrates and fish. *Archives of Environmental Contamination and Toxicology, 38.* 283-297. DOI: 10.1007/s002449910038.
[567] U.S. EPA (1995, March a). *Great Lakes Water Quality Initiative criteria documents for the protection of wildlife* (EPA/820/B-95/008).

specifically based on mercury toxicity in birds that feed on fish, and thus is an appropriate benchmark to use for the Rainy River-Headwaters as well even though legally the Rainy River-Headwaters has a higher ambient water quality standard.

The EPA undertook a similar review and assessment to determine a safe level of mercury in surface waters to protect developing fetuses whose mothers eat fish. Based on a Great Lakes region-wide assumption about how much fish people eat, that level was set at 1.8 ng/L.[568] The Fond du Lac Band of Lake Superior Chippewa, who retain treaty rights to hunt and fish in the Rainy River-Headwaters, recalculated the criteria to reflect the amount of fish that tribal members typically eat, and set the criteria at 0.77 ng/L.[569] This is an appropriate benchmark to assess the impacts of mercury on human health in the Rainy River-Headwaters.

No surface waters in the Rainy River-Headwaters or BWCAW have average mercury levels as low as 1.3 ng/L, much less 0.77 ng/L. According to data submitted by Twin Metals to MDNR, mercury concentrations in 2018 averaged as high as 6.05 ng/L[570] in the South Kawishiwi River/Birch Lake area. All of the surface waters in the area have methylmercury levels that are already affecting wildlife and human health.

The State of Minnesota also has a numeric standard for mercury in fish tissue. Based on a statewide estimate of fish consumption, Minnesota's standard is set at 0.2 mg/kg.[571] It should be noted that Minnesota's fish tissue standard does not protect people who eat more fish than the general population.

Virtually all lakes in the BWCAW and the Rainy River-Headwaters have mercury levels in fish tissue far higher than 0.2 mg/kg. The most recent data indicates an average mercury concentration in walleye and northern pike longer than 17 inches from Birch Lake of 0.68 mg/kg (2015 data) and from Gabbro Lake of 0.97 mg/kg (2016 data). Every lake between White Iron Lake and the entry into the BWCAW on Fall lake is subject to fish consumption warnings due to high levels of mercury in fish tissue.[572] Smaller lakes in the area do not have the large fish that tend to have the highest mercury concentrations, but still have alarming mercury levels: Harris Lake walleye and northern pike from 14 to 18 inches had an average of 0.74 mg/kg in 2013; and Nickel Lake walleye and northern pike from 13 to 16 inches had an average of 0.50 mg/kg in 2000.[573] Other rivers and lakes in the area, including the South Kawishiwi River, have no data, but can be assumed to be comparable.

Minnesota lakes and rivers with mercury in fish tissue above 0.2 mg/kg in greater than 10% of tested walleye or northern pike of any size class are considered "impaired" under the federal Clean Water Act.[574] Virtually all of the lakes and river reaches in Northeastern Minnesota that

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[568] U.S. EPA (1995, March b). *Great Lakes Water Quality Initiative criteria documents for the protection of human health* (EPA/820/B-95/006).
[569] Fond du Lac Band of Lake Superior Chippewa Ordinance 12/98, App. 1.
[570] Twin Metals Minnesota (2019a), line 3056 and Table 6-7.
[571] Minn. R. 7050.0220 Subp. 5a(B)(12).
[572] Minn. Dept. of Health (2000). *Fish Consumption Guidance*. Retrieved Nov. 20, 2021 from https://www.health.state.mn.us/communities/environment/fish/#waterbody
[573] MPCA (2019, March). allfish03182019-Hg.xlsx [Excel spreadsheet].
[574] MPCA (2007, March). *Minnesota Statewide Mercury Total Maximum Daily Load*.

have been tested are on the Impaired Waters List. However, many waters have not been tested. If a waterbody is not listed, it is almost certainly because it has not been tested rather than because fish tissue meets the mercury standard.

While most health benchmarks and environmental standards (including the Statewide Mercury TMDL) apply to total mercury, it is methylmercury that bioaccumulates to toxic levels in living organisms and makes fish unsafe to eat. Sulfate plays a role in methylmercury production and is one of the most common pollutants released by mining, particularly sulfide-ore mining. The addition of sulfate to low-sulfate wetlands accelerates the metabolism of anaerobic bacteria, and increases their rate of decomposition of sediment organic matter, significantly increasing the *amount* of mercury released into the water column.[575] A second interaction between sulfate and mercury is that the addition of sulfate to low-sulfate waters and wetlands with an organic substrate increases the *rate of mercury methylation*. Cycling between wet & dry spells, including spring snowmelt, flushes methyl-mercury out of wetlands and into streams and the water column of lakes downstream.[576,577]

In waters where sulfate levels are naturally low, a very small increase in sulfate can result in a significant increase in methylmercury,[578,579] even if there is no increase in mercury itself.[580] This is particularly true in wetlands, as indicated by research at an experimental station in north-central Minnesota. In May 2002 sulfate was sprayed onto a wetland, raising the sulfate concentration from very low (0.02 mg/L) to the seemingly low level of 1.1 mg/L, which resulted in a significant increase in the production of methylmercury.[581] At least six other peer-reviewed publications have also demonstrated that the addition of sulfate to natural systems increases the production of methylmercury.[582]

Birch Lake provides near-perfect conditions for increased mercury methylation, which is borne out by the high mercury levels in Birch Lake fish. First, the lake already has an elevated sulfate level. The sulfate level in Birch Lake near the Maturi project site is more than an order of magnitude higher than in creeks draining the site.[583] Levels are particularly high in the two rivers and bays that receive taconite mining discharge (Dunka River and Bay, and Unnamed Creek and

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[575]Myrbo, et al. (2017a). Increase in nutrients, mercury, and methylmercury as a consequence of elevated sulfate reduction to sulfide in experimental wetland mesocosms. *Journal of Geophysical Research: Biogeosciences*, *122*, 2769–2785.
[576] Engstrom, D.R. (2017).
[577] *See also* Seitz, G. (2015, Nov. 16). Field notes, The sulfate cascade: Measuring mercury at Marcell. *Science Museum of Minnesota.* https://www.smm.org/scwrs/fieldnotes/sulfate-cascade-measuring-mercury-marcell
[578] Branfireun, B.A., Roulet N.T., Kelly, C.A., & Rudd, J.W.M. (1999). In situ sulphate simulation of mercury methylation in a boreal peatland: toward a link between acid rain and methyl mercury contamination in remote environments. *Global Biochemical Cycles, 13,* 743-50.
[579] Jeremiason, J.D., Reiser, T.K., Weitz, R.A., Berndt, M.E., & Aiken, G.R. (2016). Aeshnid dragonfly larvae as bioindicators of methylmercury contamination in aquatic systems impacted by elevated sulfate loading. *Ecotoxicology, 25*, 456–468. https://doi.org/10.1007/s10646-015-1603-9
[580] McCarter, C.P.R., Branfireun, B.A., & Price, J.S. (2017). Nutrient and mercury transport in a sub-arctic ladder fen peatland subjected to simulated wastewater discharges. *Science of the Total Environment 609*, 1349-1360.
[581] Jeremiason, J.D., Engstrom, D.R., Swain, E.B., Nater, E.A., Johnson, B.M., Almendinger, J.S., Monson, B.A., & Kolka, R.K. (2006). Sulfate Addition Increases Methylmercury Production in an Experimental Wetland. *Environmental Science & Technology, 40,* 3800-3806. DOI: 10.1021/es0524144
[582] Myrbo, et al. (2017a).
[583] Pugh, L. (2021).

Bob Bay), and remain above 10 mg/L for a significant distance down-lake to the outlet of Stoney River (which has a sulfate level of less than 1 mg/L). Downstream of the Stoney River outlet, levels are primarily in the 5 to 7 mg/L range. This is within the range where a significant increase in mercury methylation would be expected from the addition of less than one milligram per liter of sulfate.

Second, Birch Lake receives water from wetlands, a particularly effective environment for methylating mercury.[584] Water from wetlands feed nearby lakes and streams through creeks and in seepage through groundwater, but even when wetlands are isolated their water flushes out to lakes and streams with snowmelt or large precipitation events.[585] In the Maturi project area, large areas of peat wetland are located immediately to the east of the planned ventilation raises and northeast of the plant and tailings disposal area. Significant wetland area is also located immediately south of the proposed tailings disposal area. These areas would likely receive sulfur both from emissions and fugitive dust and from leachate and seepage from the tailings and other facilities. These areas drain primarily to creeks that feed Birch Lake and the South Kawishiwi River.

Northeastern Minnesota's famously extensive wetlands make it an extremely problematic location for any activity that releases sulfate to the environment. Dr. Branfireun, who has knowledge of perhaps every mercury methylation study that has been conducted worldwide, has stated that "in no other surface waters that I am professionally aware of are the fractions of total mercury as methylmercury as high as are reported in the [NorthMet] FEIS."[586]

Finally, the water level of Birch Lake is subject to large fluctuations controlled by a dam,[587] another high-risk factor for mercury methylation.[588] According to the Twin Metals state data submission, the project could add another two inches to that fluctuation.[589] While Twin Metals minimizes this impact, a two-inch drop on a lake as large as this one could expose a significant area of lake sediment to the drying/wetting cycle that contributes to methylation. Increases in the number of fluctuations each year or a different fluctuation regime could also add to the risk of increased methylation. The South Kawishiwi River is also subject to large variation in water levels;[590,591] as far as we know, no data exists that could shed light on whether this may contribute to higher mercury levels in fish tissue in the South Kawishiwi River.

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[584] Wentz, D.A., Brigham, M.E., Chasar, L.C., Lutz, M.A., & Krabbenhoft, D.P. (2014). *Mercury in the Nation's streams—Levels, trends, and implications.* U.S. Geological Survey. https://pubs.usgs.gov/circ/1395/pdf/circ1395.pdf

[585] Branfireun, B.A. (2015). *Expert Review of the NorthMet Mining Project and Land Exchange Final Environmental Impact Statement*. Prepared for WaterLegacy.

[586] *Id.*

[587] Twin Metals Minnesota (2019a), lines 3801 to 3803.

[588] Eckley, C.S., Luxton, T.P., Goetz, J., & McKernan, J. (2017). Water-level fluctuations influence sediment porewater chemistry and methylmercury production in a flood-control reservoir. *Environ. Pollution, 222*, 32–41. doi:10.1016/j.envpol.2017.01.010

[589] Twin Metals Minnesota (2019a), lines 3794 to 3798.

[590] *Id.,* Table 6-5.

[591] U.S. Geological Survey (n.d.b) *National Water Information System, USGS 05125000 South Kawishiwi River near Ely, MN.* U.S. Dept. of Interior. Retrieved April 13, 2020, from https://nwis.waterdata.usgs.gov/mn/nwis/uv/?cb_00021=on&cb_00060=on&cb_00065=on&format=gif_default&site_no=05125000&period=&begin_date=2019-04-13&end_date=2020-04-13

As Branfireun points out, the dewatering of wetlands due to the cone of depression created by mining and their subsequent inundation after mining ends provides an environment that is particularly conducive to mercury methylation.[592] The addition of increased sulfate and mercury levels to this environment would provide a "perfect storm" in terms of the impacts on downstream fish.

As discussed in previous sections of these comments, sulfide-ore copper mining in the Duluth Complex would inevitably increase sulfate and mercury in wetlands and other surface waters, resulting in increased mercury methylation in the environment and increased mercury levels in downstream fish.

Environmental review should consider the ways in which sulfide-ore copper mining would increase mercury and sulfate loading to the low-sulfate wetlands and other waters of the Withdrawal Area, and the consequence of these increases, i.e., increased mercury loading in fish tissue downstream, including in lakes already listed as impaired.

D. The proposed Withdrawal is essential to protect terrestrial resources in the Superior National Forest

As is true for water resources, the BWCAW and Rainy River-Headwaters comprise the largest and highest quality, most intact ecosystem and wildlife habitat area within Minnesota, and one of the largest such areas in the Eastern United States. Loss or degradation of habitat and ecosystems in this watershed, we would be to lose something of inestimable value. As the Forest Service has recognized, the Boundary Waters and the adjacent Rainy River-Headwaters area provide an important refuge for boreal wildlife species with declining populations, which in the face of climate change may be critical to the continued existence of these species in Minnesota.[593] This is true of threatened and imperiled plant communities as well.

The Rainy River-Headwaters outside of the BWCAW is worthy of protection in its own right. Impacts to ecosystems, plant communities, wildlife, and wildlife habitat in adjacent areas outside the wilderness would have impacts within the wilderness as well. That would run counter to federal policies granting the highest level of protection for wilderness resources.

Federal mineral leases that would be developed by the currently pending mine plan for the Maturi project lie directly adjacent to and upstream of the BWCAW.[594] Lease MNES-01353 adjoins the Wilderness in two places. Lease MNES-01352 is located approximately five miles from the Wilderness boundary. The proposed Maturi copper-nickel processing site would be within 6 miles of the Wilderness, close to the shore of Birch Lake. Twin Metals' original plans (which it is reasonably foreseeable could be developed into a new or expanded mining proposal in the future if there is no Withdrawal) also include the Maturi SW deposit, located on MNES-01352 within one-quarter mile of Birch Lake. Twin Metals and other mining companies also

[592] Branfireun, B.A. (2019). Expert Review of the Minnesota Pollution Control Agency Clean Water Act Section 401 Certification for the NorthMet Project. Prepared for WaterLegacy.
[593] U.S. Forest Service (2016, Dec. 14).
[594] Garwin, R. (2015, Feb.). Mineral interest locations. [Map]. Northeastern Minnesotans for Wilderness.

hold additional prospecting permits and state leases nearby. Impacts of mining, if allowed in the watershed, would affect ecological and wildlife resources. If more than one deposit were mined, the cumulative impacts would not likely be adequately considered in permitting, and should be considered now, at a programmatic level review.

The Superior National Forest (SNF) coincides with a substantial lobe of southern boreal forest, and covers three million acres, 1.1 million acres of which is the Boundary Waters Canoe Area Wilderness and 222,000 acres of which is the Mining Protection Area (withdrawn from mining by the BWCAW Act of 1978). The proposed Withdrawal Area would add 225,378 acres to the area outside the BWCAW that is currently protected from mining.

The SNF supports a broad spectrum of both ecological and human recreational and commercial uses. The natural landscape of forests and water supports a diversity of life and also draws visitors as well as seasonal and permanent residents to the area. The entirety of the SNF is open to hunting and fishing and offers a wealth of land- and water-based outdoor recreation opportunities.[595] The SNF is the fourth largest and eighth most visited national forest in the country.

As a mining industry spokesperson put it, "Mining by its nature and scale causes significant changes in the landscape and ecosystem."[596] The development of sulfide ore mining within the Rainy River-Headwaters would transform the ecosystem of this area from a healthy, well-managed, productive multiple-use national forest that supports a full range of recreational and economic activities into an industrial area that would be devoid of nearly all the natural resource and community values it now provides. While these landscape and ecosystem injuries, risks, and lost values and uses might be deemed acceptable in some places, the Forest Service was right to conclude they are unacceptable in the heart of a heavily-used water-based scenic recreation area, in the headwaters just upstream from the most-visited wilderness area in the nation, and in a region where society and cultural values and the economy are dependent upon the high-quality and reputation of the land and water resources.

I. Forest resources would be degraded in the BWCAW as well as in the immediate mining area

Mining would cause a direct loss of large areas of important plant communities and high biodiversity areas in the Rainy River-Headwaters watershed, as discussed below. In addition, mining and its direct impacts would also have harmful secondary effects in and beyond the areas of primary impacts. The Withdrawal Area would experience forest fragmentation, invasive species spread into high-quality areas, loss of soil productivity, and destabilizing changes in water chemistry and hydrology. A peer-reviewed and published paper by Professor Lee Frelich of the University of Minnesota's Center for Forest Ecology outlines the many ways that mining would impact forest ecology and wildlife habitat; that paper is incorporated herein.[597]

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[595] U.S. Forest Service (2005, June). *Superior National Forest recreation niche – "A superior recreation experience."* U.S. Dept. of Agriculture. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_048974.pdf
[596] Eger, P., & Ongaro, F. (2014). *Successful non-ferrous mining: Promise or reality?* [PowerPoint presentation].
[597] Frelich, L.E. (2019).

In addition to the effects on resources in the immediate vicinity of mining operations, mining would have a significant secondary footprint that would extend into the BWCAW. Frelich (2019) outlines the many ways that mining development outside the BWCAW would likely have impacts within the Wilderness.

> Potential negative impacts include disruption of population dynamics for wildlife species with migration routes, or metapopulations of plant species that span the wilderness boundary, and establishment of invasive species outside the wilderness that could invade the wilderness. Due to linkages between aquatic and terrestrial ecosystems, acid mine drainage can impact lowland forests, which are highly dependent on chemistry of water flowing through them. The expected extremes in precipitation and temperature due to warming climate can also interact with mining impacts to reduce the resilience of forests to disturbance caused by mining.

Frelich lists 25 different types of individual and cumulative impacts on forest and other ecosystems that may occur to some degree within the BWCAW from sulfide-ore copper mining in the Withdrawal Area. The table displaying these impacts is reproduced below.

Table 1. Summary of potential mining and exploration impacts on forest and other terrestrial ecosystems. Footprint column shows whether a given impact would be in the primary or secondary footprint, or both. Please note that all impacts with a "2" can occur within the BWCAW. The last two columns show whether a given impact would occur from exploration and/or mining. Please note that exploration for Cu and Ni deposits was/is not allowed within the BWCAW.

Impact	Foot-Print	Explora-tion	Mining
Baseline vegetation impacts			
Loss of forest acreage by type	1	×	×
Forest composition change by forest type	1,2	×	×
Loss of non-forest vegetation by type	1	×	×
Non-forest vegetation change by vegetation type	1,2	×	×
Loss of old-growth forest remnants, acres by forest type	1	×	×
Loss of old forest (80–120 years), acres by forest type	1	×	×
Loss of primary forest remnants, acres by forest type	1	×	×
Fragmentation (additional effects listed below under wildlife and rare species)			
Edge to area ratio due to roads, transmission lines, parking, tailings, buildings, residential and commercial development	1,2	×	×
Environment effects in remaining forest within primary footprint	1	×	×
Changes in native edge versus interior plant and tree species	1,2	×	×
Road salt effects on trees and water	1,2		×
Water flow effects on vegetation	1,2	×	×

Table 1. *Cont.*

Impact	Foot-Print	Explora-tion	Mining
Wildlife, all impacts are per species for the relevant species group			
Area-sensitive mammals, marten, fisher (fragmentation effect)	1	×	×
Area-sensitive birds, warblers, etc. (fragmentation effect)	1	×	×
Loss of nesting habitat by forest type and bird species	1	×	×
Loss of habitat acres by wildlife species and vegetation/forest type	1	×	×
Effects on species sensitive to aquatic and aerial chemistry (amphibians)	1,2	×	×
Effects on wolves and trophic cascades (fragmentation effect)	1,2		×
Effects on deer and deer-moose relationships (fragmentation effect)	1,2		×
Roadkill effects (fragmentation effect)	1,2		×
Road salt effects (fragmentation effect)	1,2		×
Corridor disruption for mobile but non-flying species	1,2		×
Loss of critical stopovers for migrating species	1,2		×
Disruption of landscape pattern of vegetation/habitat	1		×
Noise, light, and vibration effects	1,2	×	×
Rare species			
Direct habitat loss per species	1	×	×
Impacts on local populations and regional stability of metapopulations per species (plants, wildlife, soil dwelling, and saproxylic species)	1,2	×	×
Invasive species			
Transport by equipment and soil movement per species	1	×	×
Potential response to fragmentation per species	1,2	×	×
Soils and productivity			
Acidification by water and air movement	1,2		×
Movement and effects of heavy metals in the soil	1,2		×
Loss of soil complexity	1	×	×
Terrestrial-aquatic linkages			
Accelerated ecosystem aging	1,2		×
Water chemistry effects on landscape arrangement of marshes, sedge meadows, peatlands, bogs, shrub carrs and wetland forests	1,2		×
Changes in water flow effects on landscape arrangement of wetland vegetation types	1,2		×
Heavy metal movement across aquatic-terrestrial boundaries	1,2		×
Cumulative impacts			
Spatial cascade of fragmentation effects including deer, moose, forest type, invasive species interactions	2	×	×
Sensitivity of future trajectory of forest and wildlife impacts to number of exploration sites and total size of primary footprint	1,2	×	×
Synergy among climate change, invasive species and mining impacts potential to overcome ecosystem resilience	1,2	×	×

While the creation of a secondary footprint is virtually certain, the specific area and effects are not predictable, and thus are unlikely to be adequately considered when permitting individual mining operations.

II. Mining would result in ecosystem and plant community degradation and loss

Both the Withdrawal Area and potentially affected areas in the BWCA host high-quality natural plant communities, and are important for biodiversity within the Superior National Forest and the state of Minnesota.

a. Important natural plant communities and areas of high biodiversity would be degraded or destroyed by mining in the Withdrawal Area

The Withdrawal Area contains important biological resources that would be degraded or destroyed by mining. Proposed mining areas contain significant acreage[598] of both high biodiversity areas[599] and native plant communities that are ranked as imperiled or vulnerable to extirpation within the state,[600,601,602] as determined by the Minnesota Biological Survey, a program of the Minnesota Department of Natural Resources. In the SNF, including within the Withdrawal Area, MBS biodiversity significance ranks are influenced by the surrounding contiguous natural landscape and relative lack of fragmentation. These sites not only reflect exceptional biodiversity locally and statewide, but many harbor species and communities of regional and national significance. [603,604,605]

Any sulfide-ore copper mine in the Duluth Complex would require so much land that destruction of significant acreage of these high-value natural communities would be inevitable. Additional large acreages within the secondary footprint would be degraded, sometimes to the extent that the acreage would lose the qualities that gave it the designation. Withdrawal of federal lands from mining would help ensure the continued existence of these communities in Minnesota.

This is an issue for which consideration of impacts from multiple mines is particularly necessary. The federal government recently traded away a large acreage of jack pine-black spruce woodland (classified as imperiled or vulnerable to extirpation)[606] for the NorthMet project.[607] Some of that acreage will be immediately destroyed if the NorthMet project goes forward; the entire acreage has lost the protection of public ownership. Twin Metals' proposed Maturi mine project would

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598 Wolfe, J. (2021, Nov. 30). Federal Mining Protection Area, State of Minnesota Mineral Management Corridor, Duluth Complex Deposits, and Sites of Biodiversity Significance. [Map]. Northeastern Minnesotans for Wilderness.
599 MDNR (2014, Aug.). *Areas of Biodiversity Significance in Minnesota – As determined by the Minnesota Biological Survey (MBS), 1987 - 2014*. https://www.dnr.state.mn.us/eco/mcbs/biodiversity_guidelines.html.
600 MDNR (n.d.c). *Minnesota's Native Plant Communities*. https://www.dnr.state.mn.us/npc/index.html.
601 MDNR (2020, Mar. 17). *Conservation Status Ranks for Native Plant Community Types and Subtypes*. https://files.dnr.state.mn.us/natural_resources/npc/s_ranks_npc_types_&_subtypes.pdf.
602 MDNR (2020, April 1). *MN DNR Native Plant Communities*. https://mnatlas.org/metadata/dnr_native_plant_communities.html.
603 MDNR (n.d.d). *MBS Survey Procedures*. http://www.dnr.state.mn.us/eco/mcbs/procedures/index.html.
604 MDNR (n.d.e). *MBS Site Biodiversity Significance Ranks*. http://www.dnr.state.mn.us/eco/mcbs/biodiversity_guidelines.html. *See* Guidelines for Ranking of Sites of Biodiversity Significance and Draft Map of Areas of Biodiversity Significance in Minnesota
605 MDNR (n.d.f). *Minnesota Biological Survey Native Plant Community and Rare Species County Maps.* http://www.dnr.state.mn.us/eco/mcbs/maps.html.
606 Minn. Board of Water and Soil Resource & MDNR (2017). Wetland Conservation Act Technical Guidance on "Rare Natural Communities."
607 NorthMet FEIS pp. 5-409, 5-411.

impact acreage of the same community type,[608] as would future mining projects. The federal agencies should consider the trajectory for the black spruce/jack pine community given losses due to mining, climate change, and other factors, and whether preventing losses to mining within the Withdrawal Area would contribute to the continued existence of this community in the state.

The NorthMet project could also result in the destruction of more than 1,700 acres of areas of High Biodiversity Significance.[609] As with many other impacts, this was deemed acceptable because it represents "only" two percent of high biodiversity acreage in St. Louis County. This decision is alarming for what it presages regarding cumulative losses of biodiversity within the Superior National Forest if the entire Duluth Complex is allowed to be developed.

In addition to high biodiversity areas and important natural communities, the Withdrawal Area contains specific important ecological sites. The Keeley Creek Research Natural Area is located about a mile due east (downwind) of the proposed Twin Metals tailings facility, and the contiguous Harris Lake National Natural Landmark (with the Forest Service management designation of Unique Biological Area) lies just beyond. The Forest Plan provides the following direction for Research Natural Areas:

> The focus is on preserving and maintaining areas for ecological research, observation, genetic conservation, monitoring, and educational activities. The role of these areas in ecological research and monitoring is in providing unique or high quality representative native plant community types. These areas often serve as baseline or reference areas for comparison to other similar ecosystems that are subject to a wider range of management activities. These areas are very suited to monitoring of succession and other long-term ecological changes.[610]

Unique Biological Areas have "outstanding biological and other special values."[611] The management area designation "preserves these values," with management "primarily . . . for interpretive purposes." The area at issue here is also a National Natural Landmark, a designation given by the National Park Service to encourage preservation of "areas of exceptional natural value to the nation as a whole."[612] The program is designed to identify and preserve the best illustrations of the various biological and geological features of our nation. There are only eight National Natural Landmarks in Minnesota, two of which are in the Superior National Forest.[613] Our understanding is that the landmark and the RNA together are considered a best example of an old growth jack pine/black spruce forest,[614] an ecosystem that is considered imperiled or threatened with extirpation in Minnesota pursuant to the Minnesota Biological Survey.

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[608] Twin Metals (2019b), line 2393, Table 3-8, and Fig. 3-24.
[609] NorthMet FEIS p. 5-411.
[610] U.S. Forest Service (2004, July). *Superior National Forest Land and Resource Management Plan.* U.S. Dept. of Agriculture, p. 3-34.
[611] *Id.,* p. 3-28.
[612] 36 C.F.R. § 62.1(a).
[613] National Park Service (2021, Aug. 30). *National Natural Landmarks Directory*. U.S. Dept. of Interior. Retrieved Nov. 22, 2021 from https://www.nps.gov/subjects/nnlandmarks/nation.htm.
[614] U.S. Forest Service (1989). Letter conveying RNA establishment records, dated February 26, 1942, for the Keeley Creek and Lac La Croix Natural Areas. U.S. Department of Agriculture.

Any impacts that would degrade the ecology of the RNA and National Natural Landmark from a pristine condition would conflict with the reason for their existence. Blowing dust, sulfur, and metals would inevitably affect soils, vegetation, and water in these areas, altering a pristine ecosystem that serves as a baseline or reference area and a "best example" of an ecosystem that may be imperiled at the state level. The existence of unimpacted natural communities is necessary for scientific study and understanding of true natural conditions and the ways they are altered by human activities and natural events.

b. Forest destruction would have extended impacts due to fragmentation and edge effects

Impacts from the destruction of high-quality, intact forest acreage will not be limited to the acreage that is destroyed, i.e, the "primary footprint." Permanent or long-term conversion of thousands of acres of natural vegetation into industrial mining uses would have many effects on remaining vegetation, ecosystems, and wildlife habitat near the converted areas.

Many of the impacts that would be expected to both plant communities and wildlife are due to "edge effects." Frelich notes that destruction of old growth forests outside of the Boundary Waters leaves old growth stands inside the Boundary Waters more vulnerable to such effects. Former interior forest habitat would become edge habitat, inviting non-native plants and animals to colonize and compete with native species. Establishment of invasive species in large tracts of newly-exposed soil surfaces near the Wilderness puts them in a position to spread into the BWCAW. Significant micro-climate alterations would also occur in the new edge forest (warmer, drier air; higher wind speeds) as a result of increased edge-to-interior ratio and more wind damage would occur to trees in the new forest edges around the mine footprint(s); forest composition would be altered; interior forest habitat would be lost, and edge habitat that favors many invasive species would be established.

Edge-adapted species, especially weedy species of native and nonnative plants and animals, respond to the change in environment at the expense of forest interior species, and these impacts can extend deep into otherwise undisturbed forests.[615,616] The building of new roads, industrial traffic, and the introduction of new equipment near the mine site introduces invasive species. Several of these species are already reported within the BWCAW and other parts of the region.[617,618] Field notes from the Minnesota Biological Survey in 2011 indicated that already many non-native thistles and weeds were slowly spreading along roads, brought in by human activity and equipment.[619] Minimizing seed sources around the edge of the BWCAW is key to maintaining healthy plant communities in the BWCAW.[620]

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[615] Frelich, L.E. (2014). *Forest and terrestrial ecosystem impacts of mining*.
[616] Powell, R.A. (2017). *Mammals and mining in sulfur-bearing rock formations in northeastern Minnesota.* Prepared for Northeastern Minnesotans for Wilderness.
[617] U.S. Forest Service (2014, Jan.). *Non-native invasive plants and animals known on the Superior National Forest*. U.S. Dept. of Agriculture. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd476229.pdf
[618] U.S. Forest Service (n.d.a). *Non-native invasive plant management on the Superior National Forest*. U.S. Dept. of Agriculture. https://www.fs.usda.gov/detail/superior/landmanagement/resourcemanagement/?cid=fsm91_049795.
[619] Gerdes, L. (2011). *Minnesota Biological Survey news from the field 2011.* MN Dept. of Natural Resources. https://www.dnr.state.mn.us/eco/mcbs/news2011.html.
[620] Frelich, L.E. (2014).

The Withdrawal Area is comprised of upland forests, woodlands, and forested and open peatlands that are dissected by a complex network of high-quality lakes, rivers, and streams. The presence and quality of this water is highly consequential to terrestrial as well as aquatic ecosystems. Frelich describes the terrestrial biosphere of the Quetico-Superior region as "a membrane of soil and all the organisms within, lying on top of bedrock, with water flowing through an intricate web of tree roots and associated mycorrhizae" in which the forest and aquatic resources are inextricably linked. Frelich also details a number of secondary impacts that could be expected with changes to water chemistry, flow, or water table, as well as heavy metal movement across aquatic-terrestrial boundaries. Such impacts would likely be exacerbated by increasingly frequent extreme rainfall events. Potential impacts include accelerated ecosystem aging due to acidification; the death of swamp forests and/or changes in the balance among vegetation types; changes in nutrient cycling; tree mortality; and upsets in natural buffering systems. Thus the inevitable impacts on water quality and quantity that result from mining will also affect terrestrial ecosystems

Water is important to the native ecosystems of the SNF, but so is fire. The natural plant communities in the SNF are adapted to fire, and the suppression of fire for many decades has resulted in ecosystems that are less healthy than they should be. For this and other reasons, forest management is increasingly turning to the use of fire as a management tool to shape and control fire behavior, to contain the fires that do start, and to restore natural processes and patterns to fire-adapted communities. Development of large mining industrial facilities and infrastructure would likely foreclose the return of fire as a management tool in a large segment of the SNF (including parts of the BWCAW), and consequently those areas would have less healthy vegetation if mining is allowed here. The impact of mining on fire management is further addressed below.

As the effects of establishing and operating an industrial mining complex in the watershed and upstream of the Boundary Waters accumulate and "synergize" with invasive species and climate change, the resilience of the forest will be compromised both in the primary footprint of the mining district and "well into the secondary footprint inside the wilderness."[621] Potential impacts include: wetland forests being converted as warmer temperatures increase evaporation, or by changes in flow of water or grazing by deer on seedlings; loss of sensitive species due to habitat loss and climate change; generalist and invasive species' exploiting warming temperatures and increased edge habitat; the loss of ecosystem services such as carbon storage and clean water due to the large magnitude impact of climate change on high latitude boreal forests; and increased ecosystem aging due to acidification or retrogression.

III. Mining would result in a loss of ecosystem services in the mining area and in a secondary footprint, likely extending to the BWCAW

The federal lands within the Withdrawal Area provide critical ecosystem services and watershed benefits. These services and benefits are perpetual and have already been paid for, and literally flow downstream through the Rainy River-Headwaters into the BWCAW. Mining would result in a significant loss of these services and benefits.

[621] Frelich, L.E. (2019).

Much of the forest within the watershed is a southern extension of the boreal forest. Boreal forests are one of the world's most important providers of ecosystem services. These services include: the production of soils and the control of erosion and flooding; interception and storage of surface water inflows and precipitation; purification and provision of water; cleansing and moderation of the temperature and humidity of air; production of oxygen; service as habitat for many hundreds of ecologically important and valuable species; and space for recreation. Though not typically valued by traditional markets, the benefits provided by natural areas on human wellbeing are also important considerations for natural resource management and planning.[622]

Finally, the boreal forest, including in particular forested peatlands, hold vast carbon stocks, to which new carbon is added every year.[623] Clearing thousands of acres of forest for conversion to industrial uses would cause direct emissions of carbon from the soil and immediate and long-lasting loss of forest and wetland that otherwise would continue to sequester atmospheric carbon in soil and in living biomass. Changes in the size and makeup of a boreal forest can have consequences for both local and global climate. The creation of non-vegetated surfaces would absorb sunlight, and heat and dry localized air masses. Non-vegetated surfaces would also reduce the localized cooling effects caused by photosynthesis and evapotranspiration.[624] The loss of shade and cooling capacity results in a further increase in carbon dioxide by increasing oxidation, through combustion or decomposition, of dead plant tissue that represents a long period of past carbon accumulation and storage.[625]

IV. Mining in the Rainy River-Headwaters would harm wildlife

Minnesota's southern boreal forests, particularly in the SNF and the BWCAW, harbor diverse and globally significant wildlife communities, including approximately 50 species of native mammals.[626] Important wildlife species include Canada lynx and northern long-eared bat, both of which are listed as threatened under the federal Endangered Species Act, as well as moose, wolves, and bat populations, which already face serious threats in the Withdrawal Area and are not equipped to withstand the negative effects of sulfide-ore copper mining. The Superior National Forest is also a globally important birding area. Terrestrial vegetation, mammals, and birds of the Boundary Waters watershed ecosystem would be harmed by the primary and secondary effects of mining in the Withdrawal Area.

Because of the interconnectedness of waters and uplands in the Boundary Waters area, water pollution makes its way into terrestrial vegetation and wildlife. Wildlife that consumes water (i.e., all wildlife), but particularly species that consume fish and aquatic vegetation would be affected by mining pollution.

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[622] Bear, D. (2014). Integration of ecosystem services valuation analysis into NEPA compliance: Legal and policy perspectives. In National Ecosystem Services Partnership, *Federal resource management and ecosystem services guidebook*. Duke University.
[623] Frelich, L.E. (2019).
[624] Frelich, L.E. (2014).
[625] Ruckstuhl, K.E., Johnson, E.A., & Miyanishi, K. (2007). Introduction. The boreal forest and global change. *Phil. Trans. R. Soc. B Biol. Sci. (2008) 363,* 2245-2249. doi:10.1098/rstb.2007.2196.
[626] Powell, R.A. (2017).

Habitat would be further degraded due to industrial effects of noise, traffic, light and increased human presence, including increased fatality from vehicle collisions.[627] The effect of noise on wildlife is particularly concerning as there are no wildlife-related standards or limits that mining operations would be required to meet. As described in the NorthMet EIS:

> [N]oise associated with mining activities, including noise from vehicle and rail traffic, would likely affect wildlife. Mammals can be sensitive to sound levels below the range of human hearing, which is 20-16,000 hertz. The sensitivity thresholds for animals are generally lower, some below 20 hertz (US FHWA 2011). Effects due to acute noise (such as blasting) are not well studied, but would likely cause animals to startle and would interrupt forage or nesting activities (Larkin 1994). Noise does not appear to seriously affect invertebrates or fish, but does result in some disturbance to mammals (such as startling, forage interruption, and avoidance of the area of potential effect [Larkin 1994]). Bird communication would be masked by noise if the vocalizations are less than 18-20 dB above noise levels in the environment (US FHWA 2011). Changes in communication have been known to result in decreased reproduction and anomalies in learned vocalizations (Larkin 1994). Songbird populations have been shown to decrease with noise levels as low as 35 dB (Forman and Alexander 1998).[628]

Wildlife reproductive patterns would likely be altered due to increased human presence, loss of habitat, industrial noise, and pollution. Wildlife would be subject to cumulative stresses resulting in such effects as direct and indirect mortality, decline in reproductive success, or avoidance of higher-quality habitats offering superior foraging, sheltering, mating, or thermal control.

Fragmenting large, contiguous forested areas on the edge of the BWCAW would have a deleterious effect on wildlife that could persist for decades after the closure of a mine.[629] Some of these effects include disruption of migration routes leading to disruption of key species' population dynamics; effects on species sensitive to aquatic and aerial chemistry; effects from deer-moose relationships as parasites lethal to moose spread between populations sharing a smaller territory; and loss of critical stopovers for migrating species of birds.

a. Sulfide-ore copper mining in the Withdrawal Area would impact important bird habitat

The Superior National Forest is home to many species of birds. The list of year-round residents, seasonal residents, and migrants includes 225 regular species expected to occur in the forest each year and an additional 45 casual species that occur irregularly. At least 163 bird species are known to breed in the forest (74% of the bird species that regularly breed in

[627] *See* NorthMet FEIS p. 5-443 ("Wildlife mortality generally increases with increasing traffic volumes and vehicle speed. In general, highly mobile species and habitat generalists (species that utilize a wide variety of habitats) are known to have higher road mortalities.")
[628] *Id*.
[629] Frelich, L.E. (2019).

Minnesota), among them bald eagles, ospreys, loons, and a host of wood warblers.[630,631] The BWCAW region supports the highest diversity of breeding wood warbler species anywhere in the world – 24 species, which also represents two-thirds of the wood warbler species breeding anywhere east of the Great Plains.[632] Maintenance and protection of native habitats in the SNF, including the Boundary Waters, is key to the continued population viability of some bird species in Minnesota, including the black-throated blue warbler.

The American Bird Conservancy lists the Superior National Forest as one of 100 "globally important bird areas." Thirteen of the 86 bird species identified as of significant "continental concern" by North America's two premier bird conservation consortia (Partners In Flight and the North American Bird Conservation Initiative), reside in the BWCAW region. According to Fitzpatrick, "[e]very possible effort to conserve or restore their highest-quality habitats is essential for conservation of the species [of significant continental concern]," and "therefore, maintaining the pristine condition of all BWCAW regional habitats" is vital to their long-term conservation.

Many bird species that migrate through or are year-round residents of the Boundary Waters region would be affected by habitat fragmentation, disturbance, and the contamination or loss of favored food items, some of which include species of insects that spend a portion of their life cycle in fresh water lakes and streams.[633] Fitzpatrick and Frelich indicate that forest conversion would result in direct loss of bird habitat; indirect loss of interior habitat; degradation of habitat through industrial effects (noise, traffic, light); pollution-mediated decline in bird prey species, such as caddis flies and other insects; and expanded nest parasitism.

Birds and mammals are not constrained by wilderness boundaries; wildlife that inhabit the BWCAW also use the surrounding area as habitat. Birds of the BWCAW will be exposed to mining-impacted water and food sources at mine sites located in the Withdrawal Area, and aquatic birds may use contaminated open water ponds.[634]

Nearly 100 bird species found in the BWCAW region depend on aquatic habitats for breeding or feeding during spring and fall migrations. The exceptional water quality of the Withdrawal Area and Rainy River-Headwaters is a crucial resource for them. "[D]egradation of these water resources – whether from acidification, heavy metal or other chemical pollution, nutrient loading, shoreline erosion, siltation, or other alterations and contaminations associated with mining activities – are likely to have drastic negative consequences on the populations, physiological conditions, and chemical accumulations of the fish, invertebrates, and plants that supply essential food for water birds."[635]

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630 Green, J.C. (2006). *Annotated checklist of birds of the Superior National Forest.* https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_049022.pdf.

631 Fitzpatrick, J.W. (2017). *Birds of Minnesota's BWCA and Adjacent Upstream Regions, with Comments on Conservation Implications of New Copper Mining Under Consideration.*

632 *Id.*

633 *Id.*

634 See NorthMet FEIS p. 5-466 ("common waterfowl and water birds were observed at the Tailings Basin during migration, in particular Canada goose and ducks").

635 Fitzpatrick, J.W. (2017).

As explained above, methylmercury levels in fish tissue in nearby waters are likely to increase due to mercury and sulfate releases from sulfide-ore copper mining. Methylmercury is a neurotoxin for wildlife. Bioaccumulation affects avian piscivore populations[636] at the highest trophic levels. Increased concentrations of mercury have been associated with reproductive harm and reduced reproductive success among birds and other terrestrial organisms. Mercury concentrations as low as 3.0 µg/g can cause reduced hatchability and mispositioned embryos in bird species.[637,638] Neurocognitive impacts compromise rearing, foraging, and migration fitness.[639] Elevated methylmercury in insectivorous long-distance migrants like the Black Poll Warbler may be contributing to precipitous population declines of some species.[640] Higher levels of methylmercury cause intoxication and death.[641]

Although Bald Eagles demonstrate an ability to demethylate mercury to some extent, the fish-heavy diet of the eagle makes it extremely vulnerable to methylmercury-contaminated water systems. A 2011 study suggests that Bald Eagles in the Great Lakes region are already exposed to mercury "at levels capable of causing subclinical neurological damage" and that 14-27% of Eagles may be at risk.[642]

Mercury and sulfate pollution from mining operations could also impact Minnesota's most iconic bird, the Common Loon. Loon diets that contain more than 0.3 mg/kg wet weight methylmercury have been associated with altered breeding behavior and severely reduced reproductive success in the form of decreased egg laying, decreased territory fidelity, and decreased juvenile survival.[643,644] A 2008 study of loon population characteristics in freshwater lakes indicated mercury body burdens in adult loons was increasing at an average of 8.4% per year over the 18 years of observation. Increasing mercury levels reduced the number of fledged chicks per loon pair, with highest risk loons producing 41% fewer fledged young than the reference group.[645]

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[636] Jackson, A., et al. (2016). Mercury risk to avian piscivores across western United States and Canada. *Science of the Total Environment*, *568,* 685-696. http://dx.doi.org/10.1016/j.scitotenv.2016.02.197.

[637] U.S. Geological Survey (2014). *Mercury in birds of San Francisco Bay-Delta, California- Trophic pathways, bioaccumulation, and ecotoxicological risk to avian reproduction*. U.S. Dept. of Interior.

[638] Scheuhammer, A., Meyer, M., Sandheinrich, M. & Murray, M. (2007a). Effects of environmental methylmercury on the health of wild birds, mammals, and fish. *Ambio, 36*(1)*,* 12-19. https://doi.org/10.1579/0044-7447(2007)36[12:EOEMOT]2.0.CO;2.

[639] Ma, Y., Branfireun, B., Perez, C., & Guglielmo, C. (2017). Dietary exposure to methylmercury affects flight endurance in a migratory songbird. *Environmental Pollution, 234*, 894-901. https://doi.org/10.1016/j.envpol.2017.12.011.

[640] Ma, Y., Branfireun, B., Hobson, K., & Guglielmo, C. (2018). Evidence of negative seasonal carry-over effects of breeding ground mercury exposure on survival of migratory songbirds. *Journal of Avian Biology*, *49(3).* DOI: 10.1111/jav.01656.

[641] Scheuhammer, A., Basu, N., Burgess, N.M., Elliott, J.E., Campbell, G.D., Wayland, M., Champoux, L., & Rodrigue, J. (2007b). Relationships among mercury, selenium, and neurochemical parameters in common loons (*Gavia immer*) and bald eagles (*Haliaeetus leucocephalus*). *Ecotoxicology, 17,* 93-101. DOI 10.1007/s10646-007-0170-0.

[642] Rutkiewicz, J., et al. (2011). Mercury exposure and neurochemical impacts in bald eagles across several Great Lakes states. *Ecotoxicology, 20(7),* 1669-1676. DOI 10.1007/s10646-011-0730-1.

[643] Scheuhammer, et al. (2007b).

[644] Fitzpatrick, J.W. (2017).

[645] Evers, D.C, Savoy, L.J, DeSorbo, C.R., Yates, D.E., Hanson, W., Taylor, K.M., Siegel, L.S., Cooley Jr., J.H., Bank, M.S., Major, A., Munney, K., Mower, B.F., Vogel, H.S., Schoch, N., Pokras, M., Goodale, M.W., & Fair, J. (2007). Adverse effects from environmental mercury loads on breeding common loons. *Ecotoxicology 17*, (February 2008), 69–81. doi:10.1007/s10646-007-0168-7.

Increased mercury concentrations in loons "produce strong negative effects on their physiology, feather symmetry, behavior during breeding season, and reproductive success."[646] A similar loon population survey in Canada also found a strong link between contamination and mercury and loon reproductive success.[647]

b. Federally-listed threatened species would be harmed by sulfide-ore copper mining

The Superior National Forest and BWCAW are home to two species that are listed as threatened with extinction under the federal Endangered Species Act: Canada lynx and northern long-eared bat.[648] The gray wolf was listed up until October 2020, and remains a carefully managed species.

The entirety or near-entirety of the Withdrawal Area is designated critical habitat for the Canada lynx.[649] The critical habitat in northeastern Minnesota is essential to the conservation of the lynx because it is the only area in the Great Lakes Region for which there is evidence of recent lynx reproduction, and it likely acts as a source and provides connectivity for more peripheral portions of the lynx's range.[650] The Withdrawal Area includes all or parts of a number of "Lynx Analysis Units" ("LAUs").[651] Use of the Withdrawal Area by lynx and wolves has been well documented and there is a great deal of lynx denning habitat in the Withdrawal Area.[652,653]

Without the proposed mineral Withdrawal, Minnesota's lynx population faces significant and unique threats from habitat fragmentation, as it is a widely-dispersing species with low fertility rates.[654] Absent the Withdrawal, large-scale copper mining would further disturb and fragment lynx habitat, and may convert high-quality foraging and denning habitat in the Withdrawal Area into a population sink and cumulatively damaging obstacle to dispersal.[655] Restricted dispersal holds the danger of reducing gene flow and increasing inbreeding, which further increases the probabilities of local extinction.[656] Reduction in high-quality denning habitat in core denning locations may limit reproduction in the Withdrawal Area and lead to additional dispersal by

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[646] Fitzpatrick, J.W. (2017).
[647] Tozer, D.C., Falconer, C.M., & Badzinski, D.S. (2013). Common loon reproductive success in Canada: The west is best but not for long. *Avian Conservation and Ecology 8*(1): 1. http://dx.doi.org/10.5751/ACE-00569-080101.
[648] U.S. Fish and Wildlife Service (2020, Sept. 2). *Endangered Species*. Retrieved Nov. 25, 2021 from https://www.fws.gov/endangered/species/us-species.html
[649] *See* U.S. Forest Service (n.d.b). Lynx habitat. U.S. Dept. of Agriculture. [Map]
[650] U.S. Fish & Wildlife Service. Revised Designation of Critical Habitat for the Contiguous United States Distinct Population Segment of the Canada Lynx and Revised Distinct Population Segment Boundary, 79 Fed. Reg. 54782 (Sept. 12, 2014), at 54824.
[651] *See* Miranda, A. (2017, July). Lynx Analysis Units within the proposed federal mineral Withdrawal Boundary. [Map]. Campaign to Save the Boundary Waters. *Note:* the proposed federal mineral boundaries indicated on the referenced map correspond with the 2017 proposed Federal Mineral Withdrawal boundaries which are slightly different but encompass most of the same area as the 2021-2022 Proposed Mineral Withdrawal area.
[652] Center for Biological Diversity (n.d.). Wolf and lynx sightings near the NorthMet Project, 2000-2008. [Map].
[653] Miranda, A. (2017, Aug.). Suitability of lynx denning habitat within the proposed federal withdrawal boundary. [Map]. Campaign to Save the Boundary Waters.
[654] Frelich, L.E. (2014).
[655] Emmons & Olivier Resources (2006). *Cumulative Effects Analysis on Wildlife Habitat Loss/Fragmentation and Wildlife Travel Corridor Obstruction/Landscape Barriers in the Mesabi Iron Range and Arrowhead Regions of Minnesota.* Prepared for MDNR.
[656] Powell, R.A. (2017).

young lynx from the Withdrawal Area, increasing chances of mortality. Mortality during periods of low hare density is additive rather than compensatory.[657]

Significantly, the impacts to lynx habitat from copper mining would be permanent, or at least of an extremely long duration. When the U.S. Fish and Wildlife Service ("FWS") designated critical habitat for lynx in Minnesota, it explicitly carved out the "mining district" and excluded it from the designation.[658] According to FWS, in much of this mining district, mining has removed all vegetation, and areas that are still vegetated "are extensively fragmented by the mined areas and haul roads."[659]

The permanence of the impacts of large-scale copper mining on lynx habitat is further disclosed by FWS in the 2016 Biological Opinion for the NorthMet Mine and Land Exchange.[660] FWS determined that the NorthMet Mine would result in the long-term, and in most areas, permanent loss of lynx habitat at the proposed mine site. Of the 1,719 acres of lynx critical habitat that would be destroyed, only 202 acres had the potential to be eventually reclaimed after many decades. And even these 202 acres may never be conducive to use by lynx. In addition, the loss of acreage increases fragmentation of the remaining habitat in the area.

Development of sulfide-ore copper mining would lead to an increase in roads and other transportation corridors, and an increase in traffic on those roads. An increase in traffic and roads would increase the risk and incidence of lynx-vehicle collisions, opportunistic poaching, trapping, and other take and harassment of lynx.[661] More roads and transportation corridors, along with traffic on those corridors, would lead to an increase in the number of miles of compacted snow routes within Lynx Analysis Units in the Superior National Forest. More compacted snow routes would lead to greater pressure from more bobcat intrusion.

The proposed Withdrawal would further the objectives of the SNF Land and Resource Management Plan[662] regarding lynx. These objectives include:

- to minimize building or upgrading of roads in areas that are important for threatened and endangered species habitat and habitat connectivity (O-WL-7);
- to promote conservation and recovery of Canada lynx and lynx habitat (O-WL-8);
- to manage vegetation on NFS land within lynx analysis units (LAUs) to "retain, improve, or develop habitat characteristics suitable for snowshoe hare and other important alternate [lynx] prey in sufficient amounts and distributions so that availability of prey is not limiting [lynx] recovery (O-WL-9);
- to manage vegetation on SNF land within LAUs so as to, "provide for foraging habitat in

[657] Brand, C.J., & Keith, L.B. (1979). Lynx demography during a snowshoe hare decline in Alberta. *Journal of Wildlife Mgmt. 43*(4) 827-849. http://www.jstor.org/stable/3808267.
[658] U.S. Fish & Wildlife Service, Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Contiguous United States Population Segment of the Canada Lynx, 74 Fed. Reg. 8616-01 (Feb. 25, 2009), at 8643, 8670).
[659] *Id*. at 8643.
[660] U.S. Fish and Wildlife Service (2016, Feb. 5) Biological opinion: FWS No. 03E19000-2016-B-0001 Proposed NorthMet Project and Land Exchange. Dept. of the Interior.
[661] Powell, R.A. (2017).
[662] U.S. Forest Service (2004, July), p. 2-29.

proximity to denning habitat in amounts sufficient to provide for lynx" (O-WL-10);
- to "[m]aintain and, where necessary and feasible, restore sufficient habitat connectivity to reduce mortality related to roads and to allow lynx to disperse within and between LAUs and between LAUs and [BWCAW] refugium on NFS land" (O-WL-11); and
- to participate with other agencies and landowners, "in cooperative efforts to identify, map, and maintain or restore, where feasible, linkage areas that provide habitat connectivity to allow lynx to disperse between disjunct blocks of lynx habitat at larger landscape scales" (O-WL-12).

The proposed Withdrawal would also benefit wolves. Minnesota is the only state in the lower 48 to have always had a gray wolf population. Minnesota is a regional population source for gray wolves, and the proposed Withdrawal would help the state's wolf population continue to rebound, and reduce danger to this once-precarious species.[663,664,665] In 2020, FWS removed gray wolves from protection under the Endangered Species Act, including the wolves in Minnesota.[666] FWS previously delisted Minnesota's wolves in 2011, which led to state hunting and trapping seasons for wolves in 2012, 2013, and 2014.[667] During these three years, hunters and trappers in the state killed 915 wolves.[668,669,670] Now that wolves have again been delisted, we may again have hunting and trapping seasons. Long-term to permanent impacts to wolves and wolf habitat from large-scale copper mining would be in addition and cumulative to impacts from climate change, existing mining, roads, and hunting and trapping as long as the wolf remains delisted.

The northern long-eared bat is listed as "threatened" under the Endangered Species Act. The northern long-eared bat hibernates in mines and caves in the winter, and spends summers in wooded areas. Suitable summer habitat consists of a wide variety of forested habitats where bats roost, forage, and travel, and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands.[671] Long-eared bats use hibernacula and roost trees located near the proposed Maturi site.[672]

As summarized by Dr. Ron Moen of the Natural Resources Research Institute in 2020, northern long-eared bats have plummeted on the Superior National Forest. White-nosed syndrome has devastated bat populations. From 2015-2017, capture rates of the northern long-eared bat in surveys on the Superior National Forest declined by 90 percent. And from 2017-2019, none were

[663] U.S. Fish & Wildlife Service (2011, Dec.) Gray wolf *Canis lupis.* [Fact Sheet].
[664] Powell, R.A. (2017).
[665] Emmons & Olivier Resources (2006).
[666] U.S. Fish & Wildlife Service, Endangered and Threatened Wildlife and Plants; Removing the Gray Wolf (Canis lupus) From the List of Endangered and Threatened Wildlife, 85 Fed. Reg. 69778 (Nov. 3, 2020).
[667] U.S. Fish & Wildlife Service, Endangered and Threatened Wildlife and Plants; Revising the Listing of the Gray Wolf (Canis lupus) in the Western Great Lakes, Final rule, 76 Fed. Reg. 81666 (Dec. 28, 2011).
[668] Stark, D., & Erb, J. (2013). *2012 Minnesota Wolf Season Report*. MN Dept. of Natural Resources. https://www.dnr.state.mn.us/mammals/wolves/hunting-and-trapping-background.html.
[669] Stark, D., & Erb, J. (2014). *2013 Minnesota Wolf Season Report*. MN Dept. of Natural Resources. https://www.dnr.state.mn.us/mammals/wolves/hunting-and-trapping-background.html.
[670] MDNR (2015). *2014 Minnesota Wolf Season Short Summary – preliminary analysis*. https://www.dnr.state.mn.us/mammals/wolves/hunting-and-trapping-background.html.
[671] U.S. Fish and Wildlife Service (2016, Feb. 5), p. 24.
[672] MDNR & U.S. Fish and Wildlife Service (2018). *Townships containing documented northern long-eared bat (NLEB) maternity roost trees and/or hibernacula entrances in Minnesota*.

detected. At the Soudan Mine, an important northern long-eared bat hibernacula, surveys historically detected 2000 bats. In 2019, no bats were detected, and the survey was cancelled in 2020. According to U.S. Forest Service biologist Tim Catton, researchers working on the annual bat census used to net an average of 8-10 northern long-eared bats and little brown bats[673] per night,.[674] By 2017, however, they averaged just two bats per night, and came up empty on many nights. According to a 2019 newspaper report, researchers have given up on their annual count, deciding it is better to leave any remaining bats alone.[675] Gerda Nordquist, mammologist for MDNR, commented "there's just nothing left to find."

While white-nose syndrome is by far the most severe threat for the northern long-eared bat, forest conversion results in the loss of habitat that also negatively affects the species.[676] Large-scale mining projects in the Withdraw Area would result in a loss of habitat and reduced habitat effectiveness and fragmentation, including various types of noise and transportation impacts.[677] The loss of northern long-eared bat habitat caused by mining would mostly be permanent.[678]

Additionally, although northern long-eared bats do not generally forage over water, they prey on many insects that emerge from aquatic larvae. Bats (including the northern long-eared bat) are known to accumulate mercury in their tissue, with particularly high levels in bats that feed at aquatic sites and bats that live near mercury point sources.[679] Mercury levels in some studies were above sub-lethal effect levels, indicating likely impairment of neurocognitive functioning.[680] High mercury levels have been shown to depress immunology in bats,[681] leading to speculation that mercury contributes to poor resistance to white nose syndrome. Alternatively, mercury impairment may reduce overall fitness, making bats more likely to succumb to diseases for other reasons such as reduced food intake. Another study concluded that high levels of mercury in female bats would be readily transferred to pups through breast milk resulting in potential population-level effects.[682] In his review of the NorthMet project, Dr. Brian Branfireun, and international expert on mercury methylation in the environment, concluded, "The northern long-eared bat (federally-listed), little brown bat, eastern brown bat, and yellow rail (state-listed)

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[673] Little brown bats often share winter roosts with long-eared bats and, like long-eared bats, are threatened by white-nose syndrome.
[674] Helmberger, M. (2017, July 12.) "We knew this was coming" – Bat numbers plummeting in Arrowhead. *The Timberjay*. http://timberjay.com/stories/we-knew-this-was-coming,13512
[675] Stanley, G. (2019, Dec. 8). Facing a bleak outlook, Minnesota bat researchers give up on annual count. *StarTribune*. https://www.startribune.com/facing-a-bleak-outlook-minnesota-bat-researchers-try-a-new-tack/565934002/
[676] U.S. Fish and Wildlife Service (2016, Feb. 5), p. 43.
[677] *Id.*, p. 44.
[678] *Id.*, p. 51.
[679] Yates, D.E., et al. (2014). Mercury in bats from the northeastern United States. *Ecotoxicology, 23*, 45–55. DOI 10.1007/s10646-013-1150-1.
[680] Chetelat, J., Hickey, M.B., Poulain, A.J., Dastoor, A., Ryjkov, A., McAlpine, D., Vaderwolf, K., Jung, T.S., Hale, L., Cooke, E.L.L., Hobson, D., Jonasson, K., Kaupas, L., McCarthy, S., McClelland, C., Morningstar, D., Norquay, K.J.O., Novy, R., Player, D., . . . Zanuttig, M. (2018). Spatial variation of mercury bioaccumulation in bats of Canada linked to atmospheric mercury deposition. *Science of the Total Environment, 626*, 668– 677. https://doi.org/10.1016/j.scitotenv.2018.01.044.
[681] Becker, D.J., Chumchal, M.M., Bentz, A.B., Platt, S.G., Czirják, G.Á., Rainwater, T.R., Altizer, S., & Streicker, D.G. (2017). Predictors and immunological correlates of sublethal mercury exposure in vampire bats. *Royal Society Open Science, 4,* 170073. http://dx.doi.org/10.1098/rsos.170073.
[682] Yates, et al. (2014).

are all species that . . . would be directly impacted by increased in methylmercury in wetlands impacted by the proposed project."[683]

Loss of aquatic larvae caused by mining pollution would also reduce populations or eliminate some of the most sensitive insect species from affected waters. Some sensitive species that could be lost are important food for bats. That loss of nutrition would have a minor but negative effect on long-eared bat populations. Because of the devastation to the northern long-eared bat population from white-nose syndrome, the remaining bats on the Superior National Forest and in the BWCAW area are particularly sensitive to threats to their food supplies.[684] Any negative effects on bat nutrition caused by sulfide-ore mining in the Withdrawal Area will exacerbate the precarious existence of these bats, leave them more vulnerable to white-nose syndrome-mediated depletion of fat reserves, and lead them closer to extinction locally.

c. Other mammals, include moose, would be harmed if sulfide-ore copper mining occurs in the Withdrawal Area

Other mammals would also suffer direct, indirect, and cumulatively significant harms without the proposed Withdrawal. Moose in particular already face serious threats and are not equipped to withstand the long-term or permanent negative effects of sulfide-ore copper mining in their habitat.

Moose are charismatic animals iconic to the Boundary Waters region. While the moose is not federally listed as an endangered or threatened species, it is a species of concern in Minnesota.[685] The Minnesota moose population, including within the Boundary Waters, declined precipitously from 2003 to 2013.[686] Following a petition calling for federal protection of the species,[687] the U.S. Fish and Wildlife Service declined to list the moose based on the health of the Canadian population.[688] The agency did *not* find that the Minnesota population itself was secure. The population in Minnesota has apparently stabilized over the last nine years at a much lower population density.[689] However, MDNR's moose management website acknowledges, "The

[683] Branfireun, B.A. (2019). *Expert review of the Minnesota Pollution Control Agency Clean Water Act Section 401 Certification for the NorthMet Project*. Prepared for WaterLegacy.
[684] Powell, R.A. (2017).
[685] MDNR (2013, Aug. 19). *Minnesota's list of endangered, threatened, and special concern species.* https://files.dnr.state.mn.us/natural_resources/ets/endlist.pdf.
[686] Carstensen, M., Hildebrand, E.C., Plattner, D., Dexter, M., Wünschmann, A., & Armien, A. (n.d.). *Causes of non-hunting mortality of adult moose in Minnesota 2013-2017.* MN Dept. of Natural Resources. https://files.dnr.state.mn.us/wildlife/research/studies/moose/moose_findings.pdf. (Minnesota's moose are dying at rates much higher than elsewhere in North America, and have been nearly extirpated from the northwestern part of the state. The state's northeastern population of moose declined 55% between 2006 and 2018, from a population of 8,840 to 3,030 moose.)
[687] Center for Biological Diversity & Honor the Earth (2015, July 9). *Petition to list the U.S. population of northwestern moose (Alces alces andersoni) under the Endangered Species Act.*
[688] U.S. Fish & Wildlife Service, Endangered and Threatened Wildlife and Plants; Findings on a Petition to Delist the Distinct Population Segment of the Western Yellow-Billed Cuckoo and a Petition to List the U.S. Population of Northwestern Moose, 85 Fed. Reg. 57816 (Sept. 16, 2020).
[689] DelGuidice, G.D. (n.d.). *2020 Aerial Moose Survey*. MN Dept. of Natural Resources. https://files.dnr.state.mn.us/wildlife/moose/moosesurvey.pdf. *See* Table 1 - The most recent aerial moose survey from 2020 estimates a total of 3,150 moose remaining in the state.

stability itself is good news but it does not serve as evidence for either a turnaround or a continued decline in the population of Minnesota's most iconic northwoods animal."

Minnesota's moose range has shrunk over the decades, and moose are now rarely found outside of the northern part of the Arrowhead.[690] The Withdrawal Area is squarely within what remains of Minnesota's moose habitat.[691]

Moose habitat requirements in Minnesota include adequate winter and summer thermal cover; wetlands, muskeg, and marsh; older forest stands with gaps of regenerating forest; and riparian areas. Functionally, habitat provides forage and cover. Adequate cover provides protection from heat, protection from deep snow, moderation of cold temperatures, predator avoidance, and presence of calving locations. Moose in Minnesota are increasingly challenged by warmer temperatures and changing precipitation patterns, and forest management practices within the moose's range have the potential to further significantly affect the quantity, quality, and distribution of moose habitat.[692]

Research indicates that the loss of Minnesota moose will likely continue as the species faces increasing pressures from climate change and habitat destruction.[693] Increased traffic and associated moose-vehicle collisions, forest fragmentation, density of deer that carry brainworm fatal to moose,[694] and avoidance of high-value habitats due to disturbance from mining activity are just a few mining-related negative factors for moose.

Newborn moose calves have limited mobility, which restricts movement of the mother as well. Disturbances to or shortages of forage material can significantly increase calf mortality.[695] When high-value food is not abundant and female moose are not in sufficiently good condition, breeding is delayed, fewer calves may be born, those born may receive less milk and be weaker, calf mortality may increase, and reproduction may even be skipped altogether.

When moose populations are low, the rate of population recovery depends heavily on the nutritional condition of females.[696] That condition in turn depends on the quality and availability of aquatic vegetation. Moose seek out aquatic vegetation because it tends to have more sodium than does terrestrial vegetation. Moose can be affected by a reduction in high-quality aquatic vegetation due both to sodium shortage and to an overall lower quality diet. Accumulation of toxic heavy metals in the aquatic ecosystem also poses a threat to moose.

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[690] Kolyer, A. (2015, Feb. 2). Climate change in Minnesota: 23 signs. *Minnesota Public Radio.* https://www.mprnews.org/story/2015/02/02/climate-change-primer.

[691] DelGuidice, G.D. (n.d.).

[692] MDNR (2011, Dec. 21). *Minnesota moose research and management plan*. https://www.dnr.state.mn.us/moose/index.html.

[693] McGraw, A.M., et al. (2010). An Advisory committee process to plan moose management in Minnesota. *Alces 46*, 189–200.

[694] Frelich, L.E. (2019).

[695] McGraw, A.M., Terry, J. & Moen, R. (2014). Pre-parturition movement patterns and birth site characteristics of moose in Northeast Minnesota. *Alces, 50,* 93–103.

[696] Powell, R.A. (2017).

Impacts on the moose population could affect the whole ecosystem of the BWCAW and the Rainy River-Headwaters. Large mammals, because of their size, longevity, and food and habitat requirements, have a substantial impact on ecosystems.[697] Furthermore, in northern forests a strong link exists between herbivores, decomposers, and plant life. Nutrient availability is low, limiting productivity, which strengthens the effects of herbivores and the plants they depend on in the ecosystem. Because plant tissue chemistry affects digestibility and decay, there is a close link between food webs and nutrient cycles, with herbivores playing a role in determining plant community composition as well as soil nutrient availability. The absence of key herbivores changes the interaction between plants, other foraging animals, and soil nutrients.[698] In short, impacts to moose populations will result in changes in vegetation and habitat for other wildlife.

Other mammals of the SNF are likely to be affected by sulfide-ore copper mining as well. Beavers, water shrews, and star-nosed moles, while not as charismatic or threatened on a large scale, are critical to maintaining the biodiversity of the Withdrawal Area, and will lose important foraging habitat and food sources should mining pollute waters.[699] Like many birds and bats, small mammals are impacted by methylmercury in food sources, resulting in neurotoxicity and death.[700]

Otters, mink, fishers and other species whose diets include heavy portions of fish could be harmed by local declines in fish abundance, or by bioaccumulation and toxicity of mercury and other heavy metals, if sulfide-ore mining occurs in the Withdrawal Area. "Tissue levels of mercury in otters … and minks, which eat large numbers of fishes, amphibians and crustaceans, are usually about 10x the levels found in the food in their diets, whose levels of mercury can exceed by 10^6x the background levels in the water column."[701] In addition, otters may also be exposed to significant level of pollutants through grooming after swimming in polluted waters. Otters are more sensitive to heavy metals even than loons.[702]

Some signature predator-prey systems, such as the mink-muskrat system, will be disrupted if mining pollution causes populations to fall. Any negative effects of AMD on aquatic vegetation or on muskrats will in turn affect muskrat predators, especially minks, and their ecological communities.[703]

d. Mine facilities in the Rainy River-Headwaters would result in additional losses and degradation of wildlife corridors

Due to ferrous mining and residential development, there are few remaining wildlife corridors in northeastern Minnesota outside of the BWCAW for far-ranging wildlife such as lynx, wolves, and moose. In 2006 on behalf of MDNR, Emmons and Olivier Resources assessed the loss of

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[697] Naiman, R.J. (1988). Animal influences on ecosystem dynamics. *BioScience, 38,* 750–52. doi:10.2307/1310783.
[698] Pastor, J., and Naiman, R.J. (1992). Selective foraging and ecosystem processes in boreal forests. *The American Naturalist, 139,* 690–705. http://www.jstor.org/stable/2462617.
[699] Powell, R.A. (2017).
[700] Scheuhammer, et al. (2007a).
[701] Powell, R.A. (2017). (internal citations omitted).
[702] *Id.*
[703] *Id.*

wildlife habitat and travel corridors in the Iron Range and Arrowhead region.[704] The assessment found that wildlife travel through the region is restricted "because of the extensive change to the landscape, including large mine pits, stockpiles, mining infrastructure, regional development associated with the Mesabi Iron Range, and highways." Emmons & Olivier identified only 13 remaining wildlife corridors across the 100-mile Mesabi Iron Range, and found that any additional losses of these relatively small remaining corridors might be considered significant. Additionally, due to cumulative effects of past habitat losses for mammalian species of greatest conservation need, Emmons & Olivier determined that "any future losses to the habitat requirements for these species could be considered significant."

A second similar study was prepared by Barr Engineering in 2009.[705] The Barr Report states that mining features already cover 118,314 acres along the Iron Range, including 36,962 acres of open pits, 78,620 acres of stockpiles and tailings basins, and 212 acres of facilities and infrastructure. Cumulatively, mining in this region has fragmented habitat and resulted in a loss of wildlife travel corridors, and according to Barr, "[i]t is feasible that in the future, mining in the Iron Range could potentially culminate in a 100-mile long landscape barrier that severs wildlife travel corridors, which may have impacts on dispersal, migration, and/or seasonal movements of many species." The Barr Report identified 18 remaining wildlife corridors. Of the 18, the Barr Report predicts that "four will likely become completely impassable within the next 25-30 years as a result of planned mining activities," and an additional four "will retain some functionality, but will be significantly degraded by future mining plans." Furthermore, "As wildlife are increasingly exposed to mining activity, roads, and urban centers due to the degradation of available corridors, the incidence of wildlife mortality within the corridors is likely to increase."

e. Terrestrial arthropods are affected by elevated levels of metals in the environment

Though often unnoticed or dismissed as pests, terrestrial arthropods (including insects, arachnids, myriapods, and other invertebrates) play an indispensable role in ecosystem health. Terrestrial arthropods pollinate local vegetation, act as biological population controls, help maintain soil structure, release nutrients into the local ecosystem, and play crucial roles within the local food web.[706] Heavy metals released by mining can accumulate in terrestrial arthropods, reducing overall fitness and potentially increasing mortality. Heavy metals of toxicological concern include zinc, copper, cobalt, nickel, selenium, arsenic, and cadmium. Although the toxicological effects of heavy metals vary greatly between insect species, possible impacts include reduced

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[704] Emmons & Olivier Resources (2006).

[705] Barr Engineering (2009). *Cumulative Effects Analysis of Wildlife Habitat and Threatened and Endangered Wildlife Species, Keetac Expansion Project*. Prepared for U.S. Steel.

[706] Skaldina, O., & Sorvari, J. (2019). Ecotoxicological effects of heavy metal pollution on economically important terrestrial insects. In Kesari, K.K. (Ed.). *Networking of Mutagens in Environmental Toxicology* (137-144). Springer International Publishing. [Not included in Appendix].

adult fecundity,[707] damaged immune responses,[708] altered species behavior,[709] and other impacts that ultimately drive population decline.[710] The following discussion summarizes key points from the existing literature on accumulation of heavy metals in different species of terrestrial arthropods. This is not an exhaustive list, and the number and range of examples indicates the plausibility of biological implications in arthropod species in the Rainy River-Headwaters and BWCAW from increases in heavy metals in the environment.

Pollination is an extremely important role played by insects, and pollinators are in precipitous decline around the world. Although Minnesota's primary pollinator habitat is in the south-central part of the state, combatting the decline in pollinator populations everywhere is increasingly important. Around 400 species of wild bees live in Minnesota,[711] including rare boreal pollinators which reside in the northern forests such as the rusty patched bumble bee.[712]

Important pollinators species can be harmed by the environmental presence of toxins within contaminated vegetation as well as toxic atmospheric particles sized at PM10.[713] Heavy metal accumulation has been observed in both honeybees and bumble bees, with higher concentrations of nickel leading to impaired foraging behavior. In a 2013 study, a shorter bumble-bee visitation period in flowers was observed with elevated levels of nickel within nectar solutions.[714] Honeybees have also shown reduced responsiveness to sucrose after ingestion of selenium, and a 2012 study suggested that reductions in honeybee population numbers may be the result of selenium exposure.[715] These examples suggest that increases in selenium and nickel in the environment could affect pollinator bee foraging behavior in the Rainy River-Headwaters.

Butterflies and moths also provide essential pollination services to Minnesota vegetation. During the herbivorous larval stage, exposure to plants that have absorbed higher levels of contaminants can lead to accumulation at levels which could impede future development. Larvae of *Eriocrania semipurpurella* found living in a strong copper and nickel pollution gradient in northwest Russia

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[707] Moe, S.J., Stenseth, N.C. & Smith, R.H. (2001). Effects of a toxicant on population growth rates: Sublethal and delayed responses in blowfly populations. *Functional Ecology, 15,* 712-721.
[708] Sorvari, J., Rantala, L.M., Rantala, M.J., Hakkarainen, H., & Eeva, T. (2007). Heavy metal pollution disturbs immune response in wild ant populations. *Environmental Pollution, 145,* 324-328. DOI:10.1016/j.envpol.2006.03.004.
[709] Mogren, C.L., & Trumble, J.T. (2010). The impacts of metals and metalloids on insect behavior. *Entomologia Experimentalis et Applicata, 135,* 1-17. DOI: 10.1111/j.1570-7458.2010.00967.x.
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[711] University of Minnesota. (2021). *Cariveau Native Bee Lab*. Retrieved Nov. 27, 2021, from https://beelab.umn.edu/cariveau-lab.
[712] U.S. Forest Service (n.d.c). *Chippewa National Forest: Finding Rusty*. Retrieved Nov. 27, 2021, from https://www.fs.usda.gov/detail/chippewa/maps-pubs/?cid=fseprd562340.
[713] Costa, A., Veca, M., Barberis, M., Tosti, A., Notaro, G., Nava, S., Lazzari, M., Agazzi, A., & Maria Tangorra, F. (2019). Heavy metals on honeybees indicate their concentration in the atmosphere. A proof of concept. *Italian Journal of Animal Science, 18.* 309-315. https://doi.org/10.1080/1828051X.2018.1520052.
[714] Meindl, G.A., & Ashman, T. (2013). The effects of aluminum and nickel in nectar on the foraging behavior of bumblebees, *Environmental Pollution, 177.* 78-81. http://dx.doi.org/10.1016/j.envpol.2013.02.017.
[715] Hladun, K.R., Smith, B.H., Mustard, J.A., Morton, R.R. & Trumble, J.T. (2012). Selenium toxicity to honey bee (*Apis mellifera L.)* pollinators: Effects on behaviors and survival. *PLoS One, 7,* e34137. doi:10.1371/journal.pone.0034137.

contained copper concentrations almost five times the concentrations found in leaf parenchyma, pointing towards the capacity of larvae to bioaccumulate environmental toxins. Larval weight and feeding efficiency decreased with increases in foliar concentrations of both copper and nickel.[716]

Predatory insects like ants, beetles, and wasps could also face local population impacts due to increased exposure to heavy metals. As omnivores, ants can accumulate toxins by consuming either contaminated prey or vegetation. In one study, ants who were fed mercury-contaminated fish had mercury concentrations more than 3 times the levels observed in control ants,[717] and varying levels of copper, cadmium, nickel, manganese, lead, and zinc have also been observed in different ant species.[718,719] Higher bioaccumulated levels of these metals within ants suggest a relatively high tolerance, but morphology, physiology and behavior effects have been recorded. Cadmium can lead to inhibitory effects that impair ants' metabolic processes, which are necessary to carry heavy loads and are thus crucial to food collection.[720] A 2010 study of *Formica aquilonia*, a dominant territorial ant species in boreal forests as well as keystone general predator species, observed a reduction in intra-specific aggressive behavior as a result of exposure to heavy metals from a nearby copper smelter, and hypothesized that this could lead to a significant change in *Formica aquilonia* structure. Other studies have reported reduced body size[721] and smaller colony size[722] within ant populations exposed to heavy metal polluted environments. Though impacts will vary depending on ant species and type of heavy metal, it is likely that an increase in exposure to and accumulation of these toxins will create some level of fitness change within local ant populations. The capabilities of ants to accumulate higher levels of heavy metals also enables the trophic transference of these concentrations to predators, like black bears and birds.

Although research on the impacts of heavy metals to wasps and beetles is limited,[723] there is general agreement that both are capable of accumulating these toxins, especially in highly

[716] Kozlov, M.V., Haukioja., E. & Fovnatsky, E.F. (2000). Uptake and excretion of nickel and copper by leaf-mining larvae of *Eriocrania semipurpurella* (Lepidoptera: Eriocraniidae) feeding on contaminated birch foliage. *Environmental Pollution, 108,* 303-310.
[717] Migula, P., Nuorteva, S-L., Glowacka, E. & Oja, A. (1993). Physiological disturbances in ants (*Formica aquilonia)* from excess of cadmium and mercury in a Finnish forest. *The Science of the Total Environment, 134,* 1305-1314.
[718] Gramigni, E., et al. (2013). Ants as bioaccumulators of metals from soils: Body content and tissue-specific distribution of mentals in the ant *Crematogaster scutellaris. European Journal of Soil Biology, 58,* 24-31. http://dx.doi.org/10.1016/j.ejsobi.2013.05.006.
[719] Helms, J. & Tweedy, B. (2016). Invasive fire ants contain high levels of mercury. *Insectes Sociaux, 64*. DOI 10.1007/s00040-016-0514-y.
[720] Migula, P., Glowacka, E., Nuorteva, S.L., Nuorteva, P. & Tulisalo, E. (1997). Time-related effects of intoxication with cadmium and mercury in the red wood ant. *Ecotoxicology, 6*, 307–320. https://doi.org/10.1023/A:1018691130657.
[721] Skaldina, O., Peraniemi, S., Sorvari, J. (2018). Ants and their nests as indicators for industrial heavy metal contamination. *Environmental Pollution, 240.* 574-581. https://doi.org/10.1016/j.envpol.2018.04.134.
[722] Eeva, T., & Koivunen, S.V. (2004). Effects of heavy metal pollution on red wood ant (*Formica* s. str.) populations. *Environmental Pollution, 132,* 533-539. doi:10.1016/j.envpol.2004.05.004.
[723] Skaldina, O., & Sorvari, J. (2019).

polluted environments.[724] Studies suggest that for ground beetles, increased metals result in decreased hatchability,[725] severe gut damage,[726] and reduced body size.[727] These effects are all characteristic of a reduction in general fitness, which stresses local populations and could combine with other factors such as noise and light pollution or habitat degradation to induce the migration or extirpation of local beetle species.

Spiders are extremely important as the top macroinvertebrate predators in a forest ecosystem. This role as secondary consumer and population control also places spiders at high risk for heavy metal ingestion. Studies have demonstrated that exposure to heavy metals can have significant reproductive impacts in spiders – exposure to lead, zinc, and cadmium can result in reduced reproduction[728] and prolonged development.[729]

Centipedes are another important invertebrate predator within forest ecosystems, and millipedes enable nutrient cycling by decomposing leaf litter on the forest floor, making both species critical to the terrestrial forest ecosystem. Impacts of heavy meal accumulation in myriapods is relatively unstudied, but higher concentrations of heavy metals have been found in millipedes in polluted areas,[730] and cadmium exposure has been linked to cell death in soil centipedes.[731]

Several studies have demonstrated the trade-offs that occur within arthropod populations as a result of the detoxification of heavy metals.[732] Detoxification often comes at the expense of reproduction and growth, as energy must be diverted away from these processes in order to metabolize and excrete toxins. This tradeoff leave species with smaller body or pupal sizes[733,734]

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[724] Tőzsér, D., Magura, T., Simon, E., Mizser, S., Papp, D., & Tóthmérész, B. (2019). Pollution intensity-dependent metal accumulation in ground beetles: a meta-analysis. *Environmental Science and Pollution Research, 26,* 32092-32102. https://doi.org/10.1007/s11356-019-06294-5.

[725] Lagisz, M. & Laskowski, R. (2008). Evidence for between-generation effects in carabids exposed to heavy metals pollution. *Ecotoxicology, 17,* 59-66. DOI 10.1007/s10646-007-0176-7.

[726] Bednarska, A.J., Laskowski, R., Pyza, E., Semik, D., Świątek, Z., & Woźnicka, O. (2016). Metal toxicokinetics and metal-driven damage to the gut of the ground beetle *Pterostichus oblongopunctatus*. *Environmental Science and Pollution Research, 23,* 22047-22058. DOI 10.1007/s11356-016-7412-8.

[727] Sowa, G., & Skalski, T. (2019). Effects of chronic metal exposure on the morphology of beetle species representing different ecological niches. *Bulletin of Environmental Contamination and Toxicology, 102,* 191-197. https://doi.org/10.1007/s00128-018-02532-7.

[728] Maelfait, J-P., & Hendrickx, F. (1998). Spiders as bio-indicators of anthropogenic stress in natural and semi-natural habitats in Flanders (Belgium): some recent developments. In Selden, P.A. (Ed.), *Proceedings of the 17th European Colloquium of Arachnology, Edinburgh 1997* (pp. 293-300). Springer Publishing.

[729] Migula, P., Wilczek, G. & Babczynska, A. (2012). Effects of heavy metal contamination. In Nentwig, W. (Ed.). *Ecophysiology of spiders* (pp. 403-414). Springer Publishing.

[730] Kania, G. & Lechowski, J. (2012). Bioaccumulation of some elements in the millipede *Glomeris hexasticha* (Brandt, 2833) (Diplopoda, Glomerida). *Journal of Elementology, 19,* 155-164. DOI: 10.5601/jelem.2014.19.1.595.

[731] Rost-Roszkowska, M., et. al (2020). Influence of soil contaminated with cadmium on cell death in the digestive epithelium of soil centipede *Lithobius forficatus* (Myriapoda, Chilopoda). *The European Zoological Journal, 87,* 242-262. DOI: 10.1080/24750263.2020.1757168.

[732] Tovar-Sánchez, E., Hernández-Plata, I., Martínez, M. S., Valencia-Cuevas, L., & Galante, P. M. (2018). Heavy metal pollution as a biodiversity threat. In Saleh, H.E.M., & Aglan, R.F. (Eds.), *Heavy metals.* Intech Open. https://doi.org/10.5772/intechopen.74052.

[733] Jones, D.T. & Hopkin, S.P. (1998). Reduced survival and body size in the terrestrial isopod *Porcellio scaber* from a metal-polluted environment. *Environmental Pollution, 99.* 215-223.

[734] Khaliq, A., Javed, M., Sohail, M. & Sagheer, M. (2014). Environmental effects on insects and their population dynamics. *Journal of Entomology and Zoology Studies, 2,* 1-7.

and inhibited growth,[735] hindering overall species fitness.[736] A reduction in species fitness in combination with destruction of habitat could trigger overall terrestrial arthropod species population and diversity declines in the Rainy River-Headwaters and BWCAW. These outcomes have been observed in other areas with heavy metal pollution.[737,738,739]

Heavy metal accumulation can also occur within terrestrial plant communities, exposing herbivorous insects to these toxins. For example, cicadas suck fluid from plant roots, which could contain higher levels of pollutants[740] if the plants are exposed to toxins in the soil, air, or water. A study done in the vicinity of the Eagle Mine in Michigan show elevated levels of metals in berries within a two-mile radius of emission sources.[741] Arthropod populations are highly dependent on the state of local vegetation,[742] and toxic metal impacts would combine with other impacts affecting such things as plant biomass and richness to affect overall fitness.

Similar to aquatic systems, terrestrial insects, invertebrates, and other arthropods are at the base of the food web; changes in local populations could affect higher trophic levels that prey on these organisms.[743] Accumulation of heavy metals within terrestrial arthropods is transferred up trophic levels to species like birds and bats that depend on arthropods for a large portion of their diet.[744,745] Copper, cadmium, lead, and zinc have at least modest capacities for biomagnification between detritivores and their predators.[746]

[735] Posthuma, L,. & Van Straalen, N.M. (1993). Heavy-metal adaptation in terrestrial invertebrates: A review of occurrence, genetics, physiology and ecological consequences. *Comparative Biochemistry and Physiology, 106C,* 11-38. DOI: 10.1016/0742-8413(93)90251-F.
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[737] Trumble, J.T., & Vickerman, D. (2003). Impact of pollution on terrestrial arthropods. In Capinera, J. (Ed.), *Encyclopedia of Entomology* (pp. 170-173). Kluwer Academic Press.
[738] Jung, M-P., Kim, S-T., Kim, H. & Lee, J-H. (2008). Species diversity and community structure of ground-dwelling spiders in unpolluted and moderately heavy metal-polluted habitats. *Water, Air, and Soil Pollution, 195,* 15-22. DOI 10.1007/s11270-008-9723-y.
[739] Olivarius-Mcallister, C. (2014, April 21). Silverton flirting with Superfund? *Durango Herald*. https://www.durangoherald.com/articles/silverton-flirting-with-superfund/
[740] Heckel, P.F. & Keener, T.C. (2007). Sex differences noted in mercury bioaccumulation in *Magicicada cassini*. *Chemosphere*, *69*. 79-81. DOI 10.1016/j.chemosphere.2007.04.063.
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[742] Haddad, N.M., Tilman, D., Haarstad, J., Ritchie, M. & Knops, J. (2001). Contrasting effects of plant richness and composition on insect communities: A field experiment. *The American Naturalist, 158,* 17-35.
[743] Trumble, J.T., & Vickerman, D. (2003).
[744] Tovar-Sánchez, et al. (2018).
[745] Dauwe, T., Janssens, E., Bervoet, L., Blust, R. & Eens, M. (2004). Relationships between metal concentrations in great tit nestlings and their environment and food. *Environmental Pollution, 131,* 125-129. DOI:10.1016/j.envpol.2003.09.028.
[746] Paoletti, M.G., Bressan, M. & Edwards, C.A. (1995). Soil Invertebrates as Bioindicators of Human Disturbance. *Critical Reviews in Plant Sciences, 15,* 21-62.

V. Sulfide-ore copper mining in the Withdrawal Area would negatively affect important management considerations

a. Development of a sulfide-ore copper mining district within the Superior National Forest would withdraw acreage from other uses

The development of large acreages of mining facilities eliminates those areas from other uses. Uses of the Withdrawal Area for ecological and wildlife habitat purposes is addressed above; use for recreation and spiritual sustenance is addressed in other sections of these comments. In addition, the SNF is a source of other commercial products. The use of the Withdrawal Area for mining would reduce or eliminate these uses from mining areas.

The SNF is an important source of renewable pulpwood and sawtimber, harvested outside of the BWCAW and certain other protected areas by the forest products industry of northeastern Minnesota.[747] From a regional standpoint, the SNF is a major producer of timber. The harvesting and use of standing timber can be considered a short-term use of a renewable resource, and as a renewable resource, trees can be re-established if the productivity of the land is not impaired.[748] Many areas in the SNF have been logged two or more times. Though logging has temporary negative effects on forest biodiversity, nutrient cycling, and forest health, it is neither an exclusive nor a permanent use of SNF land. Other uses of forestland – hunting, berry picking, hiking, skiing, dogsledding, birding – can continue after logging, and some uses may be enhanced by it. Logging can be done in ways that promote regeneration of trees and other forest vegetation, sustain forest productivity for the future, and avoid effects on water quality, watershed health, and terrestrial and aquatic wildlife.[749,750]

b. The siting of mining facilities and infrastructure in this area would affect the ability to manage fire and to use fire for forest management

The establishment of substantial and potentially widespread industrial infrastructure in an area adapted to fire could make it more difficult to manage fire and to manage the surrounding forest lands with fire. The industrial facilities currently proposed by Twin Metals, along with the expansions and additional mines that would be sure to follow, would dramatically change the character and use of this area,[751,752] limiting the possibility of returning fire to the landscape in an intentional fashion and potentially increasing the danger to wildland firefighters due to the need

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[747] *See, e.g.,* U.S. Forest Service (2021, April 27). Integrated Resource Timber Contract Prospectus. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd893892.pdf

[748] U.S. Forest Service (2004a). *DEIS, Virginia Forest Management Project*. U.S. Dept. of Agriculture. P. 3-294. [Not included in Appendix].

[749] U.S. Forest Service (2009, Feb.). *Echo Trail Area Forest Management Project Final Supplement to the Final Environmental Impact Statement*. U.S. Dept. of Agriculture.

[750] Smidt, M., & Blinn, C.R. (n.d.) *Trees and woodlands – Logging for the 21st century.* University of Minnesota Extension.

[751] *See* Wolfe, J. (2021, Nov. 30). Federal Mining Protection Area, State of Minnesota Mineral Management Corridor, Duluth Complex Deposits, and Sites of Biodiversity Significance. [Map]. Northeastern Minnesotans for Wilderness.

[752] *See also* Wolfe, J. (2020, May 5). Federal leases on the Edge of the BWCAW. [Map]. Northeastern Minnesotans for Wilderness. (Showing the proposed industrialization of an area that presently has very little in the way of development.).

to suppress fire in an industrialized landscape. Limiting state and federal fire management options outside of the Wilderness further limits fire management options inside the Wilderness.

The southern boreal forest of northeastern Minnesota is a mosaic of ecosystems, many of which are fire-adapted.[753] Fire historically has been the major and frequent source of disturbance affecting forests of northeastern Minnesota, including in the Boundary Waters and adjacent lands. Fire helped establish, maintain, and convert vegetation communities in the forest with important variables being the frequency, intensity, and patch-size of fires. "Fire suppression has drastically changed the natural disturbance regime,"[754] and land managers have been working to address the desirability of introducing fire back into the landscape. The U.S. Forest Service has proposed using fire to improve the condition of forest vegetation; maintain or increase the area occupied by fire-dependent plant communities; and restore fire-related functions, processes, and animal habitats.[755] Specifically, the Forest Service has sought to use fire around the periphery of the BWCAW in order to reduce risks of intense fires spreading out of the BWCAW, in order to allow fire to continue to play its natural role inside the BWCAW.[756] In this landscape, periodic fire prevents the build-up of fuel that can result in catastrophic soil-layer destruction. An industrial complex would be a real impediment to letting fires burn naturally and doing controlled burns. It would almost certainly lead to wholesale suppression efforts.

This is counter to desired conditions for the BWCAW. The BWCA Wilderness Management Plan and Implementation Schedule (1993), an amendment to the 1986 Forest Plan, along with the 2004 Land and Resource Management Plan revision, describes the management and uses that are permissible in the BWCAW. A desired condition is that "[n]atural successional changes and those associated with natural phenomena, such as fire or windstorms, will be the dominant force in ecosystems."

Increased fragmentation and establishment of expensive, sunk-capital industrial facilities in the proposed Maturi project area and adjacent lands threatens to interfere with the already limited ability of the Forest Service to manage wildfire with the intent of returning more natural fire disturbance patterns and frequency to the Boundary Waters Canoe Area.[757] The 2021 fire season demonstrated that land managers are already spread thin in drought years and can ill-afford the increased difficulty that comes with development. Fire risks to mining facilities would likely drive management decisions that could lead to decreased use of fuels mitigation burns, increased risk of catastrophic fire, increased call for firefighting response, and increased risk to fire-fighter safety. Forest fragmentation would create hospitable conditions for non-native invasive species, which can contribute to the fire-fighting burden and risk to firefighters. In addition, forest fragmentation in conjunction with fire suppression and the exclusion of management burns in a large area east of Birch Lake and the South Kawishiwi River could affect deer-moose-parasite dynamics that would result in marginally increased moose mortality, which the Minnesota moose population cannot afford.

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[753] *See* Wolfe, J. (2020, Feb. 10). MBS Type Map. [Map]. Northeastern Minnesotans for Wilderness.
[754] Heinselman, M. (1996). *The Boundary Waters Wilderness Ecosystem.* University of Minnesota Press.
[755] U.S. Forest Service (2016, Aug.). *Scoping report, Hi Lo Project.* U.S. Dept. of Agriculture.
[756] *Id.*
[757] Baker, W. L. (1989). Landscape ecology and nature reserve design in the Boundary Waters Canoe Area, Minnesota. *Ecology, 70,* 23–35. doi:10.2307/1938409.

E. The proposed Withdrawal is essential to the protection of wilderness character in the Boundary Waters and of near-wilderness recreation and amenities throughout the watershed

I. The environmental review should address wilderness characteristics of the Boundary Waters as they currently exist

Federal law, including the Wilderness Act of 1964 ("Wilderness Act" or "1964 Act"),[758] requires U.S. federal agencies to protect the wilderness character of the BWCAW. This obligation extends to activities occurring beyond the wilderness boundaries but which degrade wilderness character in the BWCAW.[759] The Boundary Waters Canoe Area Wilderness Act of 1978 ("BWCAW Act")[760] banned mining in the BWCAW and established a Mining Protection Area (MPA) of 222,000 acres to protect existing natural values and high standards of environmental quality from harmful impacts of mineral development. The Act provides clear management direction to the Forest Service:

- Provide for the protection and management of the fish and wildlife of the wilderness so as to enhance public enjoyment and appreciation of the unique biotic resources of the region;
- Protect and enhance the natural values and environmental quality of the lakes, streams, shorelines and associated forest areas of the wilderness;
- Maintain high water quality in such areas;
- Minimize to the maximum extent possible, the environmental impacts associated with mineral development affecting such areas.

Wilderness character is frequently described as untrammeled, natural, and undeveloped; of offering outstanding opportunities for solitude or a primitive and unconfined type of recreation; and of possessing the unique qualities of the particular wilderness area.[761] Aspects of wilderness character include the scenic quality, air quality, water quality, the absence of modern and unnatural development and damage, darkness of the night sky, and the integrity of the soundshed. Disturbances from beyond the BWCAW, such as in the Withdrawal Area, that degrade any of these indicia would degrade wilderness character.

A partial baseline for the current threats to and current condition of the wilderness character of the BWCAW is available in the USDA-Forest Service General Technical Report titled "Mapping

[758] Public Law 88-577; 36 U.S.C. 1131-1136. The Wilderness Act of 1964 designated the BWCAW as a national Wilderness Area in the National Wilderness Preservation System to preserve and protect the lands and waters of the BWCAW in their natural condition, so they would be administered for the use and enjoyment of the American people as will leave them unimpaired for future use and enjoyment as Wilderness, and to preserve their wilderness character, among other reasons.

[759] *See Izaak Walton League of Am., Inc. v. Kimbell*, 516 F. Supp. 2d 982, 988 (D. Minn. 2007), *aff'd*, 558 F.3d 751 (8th Cir. 2009) (explaining, "the plain language of §[1133](b) makes no distinction based on the source of the allegedly degrading agency activity."). https://www.gpo.gov/fdsys/pkg/USCOURTS-mnd-0_06-cv-03357/pdf/USCOURTS-mnd-0_06-cv-03357-1.pdf

[760] Public Law 95-495; 92 Stat. 1649 (Oct. 21, 1978).

[761] Proescholdt, K. (2008). Untrammeled Wilderness. *Minnesota History*, 61, 114-123.

Wilderness Character in the Boundary Waters Canoe Area Wilderness."[762] Air and water quality were not accounted for in the report and need to be addressed in environmental review. As described elsewhere in these comments, water quality data are available for many BWCAW lakes. Air quality data exist as well, and trend plots show improvements over the last several decades.[763,764] Environmental review should examine the trends and consider how the various alternatives would influence current conditions and trends. Other improvements to wilderness character are briefly described in a memorandum by Kevin Proescholdt.[765] This is a partial list:

- The amount of the BWCAW open to and affected by motorboat use has declined;
- The area in the BWCAW open to and affected by snowmobile use has declined;
- Logging has been banned;
- Most truck and mechanical portages have been retired;
- Dams are no longer maintained;
- A series of BWCAW group size limits and entry point quotas have been added;
- Reduction in litter-prone material allowed in the BWCAW; and
- Fewer signs and structures.

In December 2021, the USFS announced planned reductions in BWCAW visitor overnight permit quotas for the 2022 permitting season for areas that suffered overuse after several seasons of increased visitor traffic.[766,767] Thanks to these and other improvements, BWCAW visitors today can enjoy a higher-quality wilderness experience, with fewer distractions from the BWCAW's unique sights, sounds, fishing and other recreational opportunities.

The above changes, and the other changes recorded in Proescholdt's memorandum, have been credibly documented, are well known to the USFS, and should be factored into the assessment of current wilderness character of the BWCAW.

II. The primitive, near-wilderness character of the Withdrawal Area should also be assessed

In addition to being the headwaters for the BWCAW, the Withdrawal Area hosts an array of recreational assets including areas with recreation-related Management Area designations including Semi-Primitive Motorized Recreation; Wild, Scenic, and Recreational Rivers; and Recreation Use in a Scenic Landscape. The MPA also has lands with these designations. These

[762] Tricker, J., Schwaller, A., Hanson, T., Mejicano, E., & Landres, P. (2017). *Mapping Wilderness Character in the Boundary Waters Canoe Area Wilderness*. Gen. Tech. Rep. RMRS-357. U.S. Dept. of Agriculture, Forest Service.
[763] *See* National Atmospheric Deposition Program maps in Appendix B folder "NADP Air quality and pollutant deposition" for maps of total sulfur deposition and particulate SO4 deposition amounts from 2000-2002 through 2017-2019.
[764] *See* Fernberg Station (NTN Site MN18) deposition trend plots for 1982-2020 for SO4, H, NO3, Na, and Cl in Appendix B folder "NADP Air quality and pollutant deposition".
[765] Proescholdt, Kevin. (2014, June 26). *Improvements to BWCAW Wilderness Character Since 1966*.
[766] Kennedy, T. (2021, Dec. 3). U.S. Forest Service will reduce access to BWCA next year in response to crowding. *Minneapolis Star Tribune*. https://www.startribune.com/u-s-forest-service-bwca-reduce-access-2022-fewer-permits-ely-tofte-gunflint-trail/600123476/
[767] U.S. Forest Service (2021, April 26). *Boundary Waters Canoe Area Wilderness Superior National Forest Permit & Visitor Use Report 2016-2020.* U.S. Dept. of Agriculture.

areas provide an important near-wilderness setting with high-quality recreational opportunities without the permit requirements or other impediments for people who are uncomfortable with or unable to travel in the wilderness. Visitors to Birch Lake and its watershed benefit in similar ways as are described above in regard to wilderness.

As explained in Part 6 below, the Boundary Waters Canoe Area Wilderness Act of 1978 includes a provision directing the Forest Service to increase opportunities for dispersed outdoor recreation outside of the BWCAW. The management designation of Birch Lake as "Recreation Use in a Scenic Landscape"[768] is a direct response to this legislation. This is one of a handful of the most used and valued scenic recreation areas in the entire forest outside the BWCAW.

Management directives for these areas reflect the intention that scenic recreation be the overriding concern for management decisions:

> The Recreation Use in a Scenic Landscape (RU) management area emphasizes land and resource conditions that provide a scenic landscape for recreational activities in natural-appearing surroundings. This management area also provides wildlife habitat to enhance recreational wildlife watching opportunities. Concentrated recreation use is common. Facilities and access may be highly developed, resulting in a high degree of user interaction. Low-density recreation is also offered in areas with remote character.
>
> Ecosystems are managed to provide a predominantly natural-appearing landscape that may be slightly modified by forest management activities. This management area emphasizes a large tree and old forest character. Vegetation management generally maintains or enhances older vegetative growth stages.
>
> Recreation and scenic integrity objectives guide the appearance of timber harvest, management-ignited fire, tree planting, and other management techniques.
>
> Vegetation management activities also enhance wildlife habitat. Management activities that promote wildlife habitat for public observation may occur.
>
> Viewsheds are managed for scenic beauty and big-tree character. Generally, this management area offers natural-looking forest surroundings with some facility and trail development and roads for recreation. Forest management enhances recreation and scenic objectives and management activities may be noticeable to visitors. Visitors to the Forest may occasionally see management activities such as timber harvest, management-ignited fire, tree planting, and other resource management techniques.[769]

In accordance with the BWCAW Act, the recreational opportunities provided on Birch Lake include “remote campsites on lightly developed lakes” and “motorized recreation experiences similar to those previously available in the Boundary Waters Canoe Area.” The Superior National Forest flyer for Birch Lake lists its features as including 14 back country campsites, 4

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[768] U.S. Forest Service (2004, July). *Superior National Forest Land and Resource Management Plan.* U.S. Dept. of Agriculture.
[769] *Id.*, pp. 3-14 to -15.

lake access sites, a developed campground, and several private resorts. The lake is described as "21-miles long and 7600 acre[s with] many beautiful islands [and] 80 miles of shoreline." "Birch Lake back country sites offer camping opportunities similar to that of the Boundary Waters Canoe Area wilderness with fewer restrictions and no permits required."[770]

Birch Lake is a very popular fishing lake. As is the case within the Boundary Waters, campers on Birch Lake often eat their catch every day during their stay. This is lake-country culture, part of what it means to "go to the lake." But Birch Lake fish are contaminated by methylmercury, and people put themselves and their children at risk if they eat walleye or northern pike more than once during a month-long visit. As described in Part 2, Section C.II.g. above, Birch Lake has many factors that make it particularly susceptible to increased methylmercury production from any increases in mercury or sulfate to its waters or biota.

In addition to all the navigable waters bordered by lands proposed to be withdrawn, the Withdrawal Area includes terrestrial recreational assets, including off-highway vehicle, dogsled, and snowmobile trails.[771] The Withdrawal Area also contains walking trails. Forest Service maps show the area contains fourteen campgrounds, five designated picnic areas, one designated swimming area on the S. Kawishiwi River, perhaps thirty backcountry campsites, one trailhead, and at least 14 Wilderness entry points. The U.S. Forest Service has singled out Birch Lake for a Watershed Restoration Action Plan, noting that Birch Lake is "an important regional recreational waterbody" and "an important recreational destination."[772]

It is important to understand that the use of motors for recreational travel – both boats and snowmobiles – does not eliminate the experience of silence and remoteness for people who travel this way. Users of both motorboats and snowmobiles often describe them as allowing access to remote areas that they could not otherwise reach, and talk of reaching a destination and then, upon turning the motor off, enjoying the silence and natural sounds. While nonmotorized travelers attempt to keep mechanical noise out of the wilderness, the corollary that motorized travelers do not appreciate silence and the sounds of nature is not true.

Both the federal and state governments have special provisions to protect lakes and streams within the boundaries of the Superior National Forest, including the Withdrawal Area. The federal law known as the Shipstead-Nolan Act establishes "the principle of conserving the natural beauty of shore lines for recreational use" for "all Federal lands which border upon any boundary lake or stream . . . which is now or eventually to be in general use for boat or canoe travel."[773] "[N]o further alteration of the natural water level of any lake or stream" may be permitted if it will result in "flooding lands of the United States."[774] A small exception is made only for logging operations or recreational uses.

[770] U.S. Forest Service (2008). *Birch Lake Back Country*. U.S. Dept. of Agriculture.
[771] Campaign to Save the Boundary Waters (n.d.a). Trails within the proposed Withdrawal Boundary. [Map]. Northeastern Minnesotans for Wilderness.
[772] U.S. Forest Service (2018). *USDA Forest Service Watershed Condition Framework, FY2018 Watershed Restoration Action Plan, Superior National Forest*. U.S. Dept. of Agriculture.
[773] 16 U.S.C. § 577a.
[774] 16 U.S.C. § 577b.

The Withdrawal would honor the intent of this legislation. To take the proposed Maturi mine as an example, the project as proposed would remove a significant area from the Keeley Creek watershed and re-route water around the tailings facility. Keeley Creek is a beautiful creek with rapids and waterfalls; downstream stretches are navigable by canoe for at least part of the year.[775] The Maturi project would alter the creek's water level and volume of flowage, and affect adjacent state and federal property. Twin Metals has suggested that it might pursue a land exchange to avoid the legal roadblocks to siting a waste disposal facility on state land. While it may be possible that such an exchange would pass legal muster, it would nonetheless frustrate the legislative intent of preserving pristine waters such as Keeley Creek in an unmodified state of nature.

III. Mining in the watershed would impact wilderness character

Establishment of a sulfide-ore copper mining district in the Boundary Waters watershed would damage protected resources in the Boundary Waters. Wilderness character is one such resource, and it is one of immeasurable value to the hundreds of thousands of BWCAW visitors. In their 2015 report "The Impacts of Mining on the Character of a Wilderness Landscape: Considerations for Federal Decision-Making," authors Reyer and Garwin describe the human value of the wilderness and the potential for damage to those values in the face of land-use changes brought on by nonferrous. The authors assert:

> Industrial-scale mining is probably the single activity that has the greatest potential for impacting wilderness character when it is undertaken outside of but in close proximity to a wilderness area. There simply is no other activity that creates the same amount of disturbance, noise, light pollution, traffic, human presence, and pollution in remote locations[776]

Noise, night lighting, and increased human activity from mining development in the Rainy River-Headwaters would negatively affect solitude, natural integrity, and primitive recreation experience within the Boundary Waters. The degradations described in this section, both separately and in combination with each other, would impair natural conditions; opportunities for solitude and primitive recreation; and significant ecological and scenic values. Comparable to water quality impacts as described above, many impacts on wilderness character are unlikely to be accurately predicted in environmental review for a particular mine proposal. Furthermore, Minnesota's mining rules and other permitting mechanisms do not provide adequate standards for many wilderness characteristics, and thus these types of impacts are unlikely to be adequately protected by permitting processes.

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[775] Pugh, L. (2020). *Keeley Creek reconnaissance and water quality sampling report*. Northeastern Minnesotans for Wilderness.
[776] Reyer, J., & Garwin, R. (2015). *The impacts of mining on the character of a wilderness landscape: Considerations for federal decision-making*. Prepared for Northeastern Minnesotans for Wilderness, p. 14.

a. Air emissions from mining operations in the Rainy River-Headwaters would reduce visibility in the BWCAW

Visibility-reducing haze caused by mine-related air pollution from outside the Wilderness boundary threatens the air quality and viewshed experience of visitors to the Wilderness. Clean air and clear views are an integral aspect of wilderness experience.

The shuttering of coal-fired power plants and the Mesabi Nugget operations have apparently resulted in progress toward clearer air in the BWCAW,[777] which is heartening. However, new mining in the area could eliminate some of the gain. The NorthMet operation alone is predicted to have visibility impacts greater than 10 percent in the BWCAW on some days.[778]

The NorthMet modeling indicates that if mines are sited closer to the BWCAW, visibility in the BWCAW is likely to deteriorate significantly, particularly if several mining operations are ultimately permitted within the watershed.[779] Modeled emissions from the NorthMet project came close to the presumed level of significance, from 21 miles away.[780] Now that baseline visibility has improved, a lower level of emissions from a new project will be more likely to cause a greater-than-five percent worsening of visibility.

As noted, the NorthMet Mine would be 21 miles from the BWCAW, and the Class I modeling for that mine did not include fugitive emissions because they were not expected to travel that distance. Fugitive emissions from facilities closer to the BWCAW would contribute to impacts. As discussed in Part 2, Section B above, fugitive emissions from the Maturi project would be expected to reach the BWCAW, as would emissions from expansions or additional mines.

We also note that in regard to air emissions, the advantage of underground mining as opposed to open pit mining lies primarily in a reduction of fugitive dust. Since fugitive dust was not included in the Class I modeling for the NorthMet mine, USFS should not assume that Maturi would be a "cleaner" mine than NorthMet in regard to visibility. Based on information from Twin Metals' 2014 Prefeasibility Report, the Maturi mine would include ventilation raises from the underground mine that emit particulate matter and other haze-forming pollutants including NOx and SO_2 through a stack at a likely rate of more than one million cubic feet of exhaust air every minute.[781] Twin Metals' state Data Submission includes an estimate of emissions from the ventilation raises, but it is not clear whether it includes all contributing sources.[782] It also appears

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[777] MPCA (2021, May 6). Regional haze visibility metrics public. Retrieved Nov. 17, 2021 from https://public.tableau.com/app/profile/mpca.data.services/viz/RegionalHaze_visibility_metrics_public/Visibilityprogress

[778] NorthMet FEIS 5-491.

[779] While the watershed is not the most appropriate boundary for considering air emissions impacts, in this case mines within the watershed will be closest to the relevant receptors.

[780] Barr Engineering (2018). *Class I Area air dispersion modeling, NorthMet Project.* Prepared for PolyMet Mining.

[781] Duluth Metals (2014, Oct.). *Twin Metals Minnesota Project, Ely, Minnesota, USA, NI 43-101 Technical report on prefeasibility study*, p. 16-24. The NI 43-101 estimates a total airflow of 3.25 million cfm would be required for mine ventilation, "which is approximately equivalent to 65 cfm/st based on a 50,000 st/d ore production rate." The same 65 cfm/st ventilation requirement applied to Twin Metals' current estimated daily ore production of 20,000 st/d would be 1.3 million cfm.

[782] Twin Metals Minnesota (2019a) lines 6073 to 6077.

that the list of other sources provided in the Data Submission is incomplete.[783] Finally, USFS should also consider the amount of power required for these operations (estimated in 2014 as 45 megawatts of continuous power[784]) and the most likely locations for generation of that power in relation to the wilderness area.

Twin Metals downplays the impacts of air emissions in its Data Submission; to our knowledge, it has not provided the data or specific source estimates needed to review its statements. Certainly, the necessary data are not included in the publicly available documents posted on BLM's and MDNR's websites. It is surprising that preliminary modeling has either not been done or the results have not been made available, as this issue was recognized as far back as the Copper-Nickel Study as having the potential to preclude mining in this area.[785]

For the most part, haze in the BWCAW is a cumulative problem. Using data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring site in the BWCAW,[786] MPCA has determined that "sulfates and nitrates continue to be the largest contributors to visibility impairment in [the area]."[787] In January and February 2020, MPCA identified seventeen facilities across Minnesota, each as "a significant source of NOx and SO_2 [located] close enough to the BWCA or [Voyageurs National Park] to potentially cause or contribute to visibility impairment in these Class 1 areas."[788] Many of these facilities are located more than 50 miles and, in some cases, several hundreds of miles from the Boundary Waters, yet data indicate that each facility may cause or contribute to haze in the Boundary Waters. Facilities that will contribute haze-causing pollution to BWCAW air at levels similar to the contributions of the worst existing facilities continue to be permitted. The significance level currently used for the analysis virtually ensures that despite the current effect of retiring coal-fired power plants, air quality and visibility will continue to deteriorate over time.[789]

b. Lighting for mining projects in the Rainy River-Headwaters would reduce the visibility of the night sky in the BWCAW

Visitors enjoy the Boundary Waters for its wild character, including excellent night sky viewing of the Milky Way, northern lights, and stars and constellations seldom seen in places affected by significant light pollution. Protection of dark sky quality is integral to the wilderness experience.

Sky glow, or the artificial brightness of the night sky caused by light pollution, is the result of scattered light in the atmosphere. This orange haze, which can be seen for miles outside of urban

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[783] *Id.,* Table 11-2.
[784] Duluth Metals (2014, Oct.), Table 21-10, p. 21-17.
[785] Ashbrook, P. (1979). *Impacts of fugitive dust emissions from a model copper-nickel mine and mill.* [Draft report]. Minn. Dept. of Environmental Quality.
[786] U.S. EPA (n.d.c). *AirData Air Quality Monitors*. Retrieved Nov. 29, 2021 from https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=5f239fd3e72f424f98ef3d5def547eb5&extent=-146.2334,13.1913,-46.3896,56.5319 (Select layer: IMPROVE (Interagency Monitoring of Protected Visual Environments) - Active: Boundary Waters; AQS Site ID 27-075-0005).
[787] MPCA (2020). *Identification of sources selected to complete a four-factor analysis*. https://www.pca.state.mn.us/sites/default/files/aq-sip2-18a.pdf.
[788] *Id.*
[789] I.e., if twenty facilities each contributed 5% of the impact, the current level of impairment would be deemed acceptable.

or densely electrified areas, is exacerbated by fugitive dust and other pollution. Light pollution and air pollution (i.e., haze) combine to degrade the clarity of the night sky. These factors must be assessed together; separate assessments of these two factors will not provide a realistic understanding of the combined impacts.

In May 2020, the USFS submitted its application for BWCAW Dark Sky Sanctuary certification.[790] The rigorous certification process includes demonstration of robust community desire and willingness to protect dark skies, as well as documentation of such things as sky quality, light pollution measures, satellite images, maps, photographs, and other evidence demonstrating the nominated sanctuary's noteworthiness as a dark-sky resource.[791] On August 31, 2020, the Boundary Waters was designated as one of just 14 "Dark Sky Sanctuaries" in the world (7 in the United States) by the International Dark-Sky Association (IDA).[792] The BWCAW is the largest dark sky sanctuary in the world. The IDA defines dark sky sanctuaries as "the most remote (and often darkest) places in the world whose conservation state is most fragile."[793]

Certification promotes public awareness, attracts night sky seekers, and carries an economic value legible to those otherwise uninterested in Dark Sky certification by promoting increased tourism and economic activity. The ability to see the night sky to the degree that it is visible in the wilderness is a tremendous cultural and spiritual resource that has guided and inspired humans since the beginning of time and is now a rarity in the United States. More than 99% of the U.S. population lives under light polluted skies; the Milky Way is not visible to more than 80% of North Americans,[794] accentuating the value of Dark Sky Sanctuaries.

Light pollution from mines in the Rainy River-Headwaters[795] would have a noticeable impact on dark sky quality within the wilderness. World Atlas 2015 maps of night lighting in the Arrowhead and the Birch Lake vicinity are reproduced below.[796] While the primary sources of light are cities and towns, taconite facilities also produce significant circles of light. For example, the bright yellow spot at the southwest end of Birch Lake is Babbitt; the yellow spot to the southeast of Babbitt is the Peter Mitchell Pit. These sources along with Ely already shrink the

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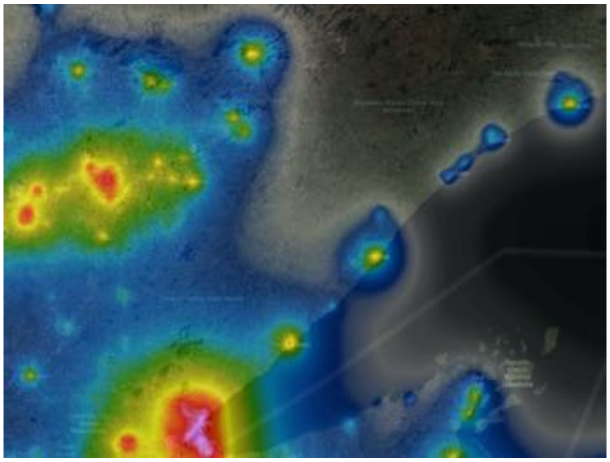
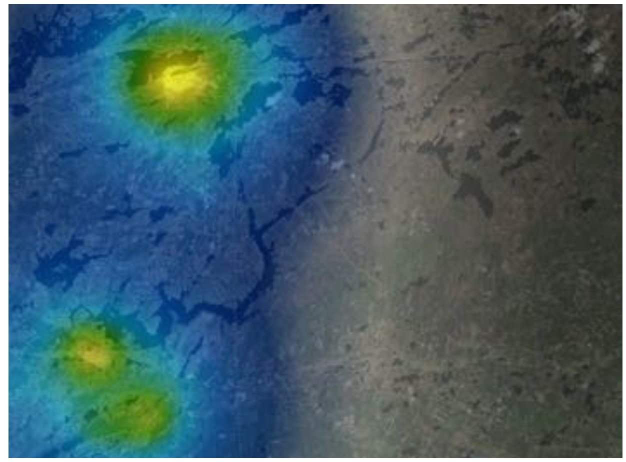
[790] Superior National Forest (n.d.b). *Boundary Waters Canoe Area Wilderness Management Area Application for International Dark Sky Sanctuary Certification.* U.S. Forest Service, Dept. of Agriculture.
[791] International Dark-Sky Assn. (2018). *International Dark Sky Sanctuary Program Guidelines*. https://www.darksky.org/wp-content/uploads/2018/12/IDSS-Guidelines-2018.pdf
[792] International Dark-Sky Assn. (2020, Sept. 15). Boundary Waters Canoe Area Wilderness named the largest dark sky sanctuary. Retrieved Nov. 22, 2021 from https://www.darksky.org/boundary-waters-canoe-area-wilderness-named-the-largest-dark-sky-sanctuary/
[793] International Dark-Sky Assn. (n.d.) *International Dark Sky Places*. Retrieved Nov. 22, 2021, from https://www.darksky.org/our-work/conservation/idsp/
[794] Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C.C.M., Elvidge, C.D., Baugh, K., Portnov, B., Rybnikova, N.A., & Furgoni, R. (2016a). The New World Atlas of Artificial night sky brightness. *Science Advances*, 2(6):e1600377. doi: 10.1126/sciadv.1600377.
[795] Again, we recognize that the watershed boundaries are not the best measure as to whether lighting will affect the BWCAW. However, it provides a good approximation for the distance within which impacts are likely to be noticeable.
[796] Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C.C.M., Elvidge, C.D., Baugh, K., Portnov, B., Rybnikova, N.A., & Furgoni, R. (2016). Supplement to: The New World Atlas of Artificial Night Sky Brightness. GFZ Data Services. http://doi.org/10.5880/GFZ.1.4.2016.001. *See* interactive light pollutions map available at: https://www.lightpollutionmap.info/ - zoom=4.00&lat=45.8720&lon=14.5470&layers=B0FFFFFFFTFFFFFFFFF

portion of the wilderness that has the very darkest skies; that area would shrink even farther if mines are located in the Birch Lake-South Kawishiwi River area.





Minnesota does not have standards that protect visibility of the night sky. Twin Metals' Data Submittal seems to take the position that if the company reduces lighting as much as is "practicable," the impacts of night lighting will not be an issue for permitting—regardless of what those impacts will actually be.[797] Because Minnesota generally takes the position that the impacts of mining are insignificant if they do not violate a quantitative standard, impacts that affect wilderness character but are not subject to quantitative standards are likely to be brushed aside in the state permitting of individual mines. In short, Minnesota's rules do not protect the BWCAW from sky glow and pollution that degrade night sky visibility.

c. Noise from mining operations in the Birch Lake-South Kawishiwi River area would damage wilderness character in the BWCAW

The experience of wilderness includes experiencing an untrammeled wilderness soundscape, which encompasses silence and solitude. "Wilderness, especially the BWCAW, is one of the last places in the U.S. where one can escape from the constant noises of civilization and be reminded that there is a world significantly less governed by human will."[798] In 2020, acoustic ecologist Gordon Hempton identified the Boundary Waters as one of fewer than ten places left in the United States where visitors can escape from the constant noises of civilization for more than 15 minutes.[799] If mining is permitted in the Birch Lake-South Kawishiwi River area, distinctive, persistent and intense noise associated with mining operations would reach the nearby Wilderness. In a wilderness setting, these impacts are felt even at what might be considered a low decibel level in more developed places. There is simply no way to "minimize" such impacts.

[797] Twin Metals Minnesota (2019a), lines 5932 to 6003 (describing measures to reduce lighting and concluding that no further modeling work is anticipated.)
[798] Reyer, J., & Garwin, R. (2015).
[799] LaGrave, K. (2020, Sept. 9). The God of Silence Speaks Up. *Microsoft News*. Retrieved Nov. 22, 2021 from https://www.msn.com/en-us/travel/tripideas/the-god-of-silence-speaks-up/ar-BB18PLu0

According to an important court ruling on activity affecting wilderness character, "Agency activity that results in sound that is louder, more constant, more frequent, or of a different quality, than the sound that presently exists within the wilderness, is more likely to degrade the wilderness character from its present condition and thus result in a violation of §4(b) of the Wilderness Act."[800] Construction and operation of a mine in close proximity to the wilderness would produce industrial noise pollution at all hours of the day, every day of the year, and for decades at a time, at distinct frequencies and volumes loud enough to be audible in the Boundary Waters. The sources of unnatural sounds would include but not be limited to drilling, blasting, heavy truck traffic and other large machinery sounds, ventilation raise fans, and generators. Such noises stand out in a wilderness setting in contrast to the natural sounds that tend to be higher frequency (and can be higher-decibel), such as the sound of wind in the trees, water lapping at the shore, and bird song. Unnatural, low-frequency sounds travel "better" through dense forest vegetation[801] and lose less energy over long distances than do high-frequency sounds.[802] For example, ventilation raises in Sudbury, Ontario produce nuisance-level noise disturbances to a community 9 km away, despite mitigation measures.[803] The Boundary Waters is within 7.25 km of the closest ventilation raise planned for the Maturi Mine.

State permitting regimes do not provide a clear mechanism for protecting many of the characteristics of backcountry recreational areas. The standard procedure is to grant a permit if an applicant can convince the agency that standards will not be violated. But impacts in remote natural areas begin before the threshold of a standard is crossed. For example, the mechanical noise associated with mining conflicts with natural recreation even if it is below the ambient noise level deemed acceptable to MPCA.

We cannot say this strongly enough: *State standards designed to protect residences in urban areas are insufficient to protect the soundscape of Wilderness.* To someone traveling in a remote setting, 30 dBA of wind and bird noise is an entirely different experience than 30 dBA of noise from haul trucks, crushers, or ventilation fans. The former reminds travelers that they are in a place of solitude, in a state of nature far removed from human intervention. The latter tells them definitively that they are not.

Exploratory noises (drilling, blasting, and truck traffic) have already been found to be disruptive in the wilderness.[804] Despite mining company assurances that noise mitigations would be followed during drilling, significant noise from Twin Metals' exploratory drilling on the leases between 2006 and 2014 damaged the Boundary Waters' wilderness character on and around Little Gabbro, Gabbro, and Bald Eagle Lakes, and the South Kawishiwi River, and severely

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[800] *Izaak Walton League of Am., Inc. v. Kimbell*, 516 F. Supp. 2d 982, 996 (D. Minn 2007).
[801] Webster, B. (1986, Feb. 11). Secret Language found in elephants. *The New York Times,* 1C. Retrieved Dec. 16, 2021 from https://www.nytimes.com/1986/02/11/science/secret-language-found-in-elephants.html
[802] Garstang, M., Larom, D., Raspet, R., & Lindeque, M. (1994). Atmospheric Controls on Elephant Communication. *J. Experimental Biology* 198: 939-95.
[803] Acuña, E., & Dobson, A. (2017). Results of the return air raise silencer system upgrade at Totten Mine. *J. of Underground Mining Technology, 2017*, 97-102.
[804] *Paddle Flashes* (n.d.) Submitted to Kawishiwi Wilderness Station, Superior National Forest, U.S. Dept. of Agriculture.

impacted the natural soundscape on and around Birch Lake.[805,806,807] The same or similar impacts would be expected to reoccur and worsen if mining is allowed in the watershed, not only from the construction and operation of mines but also from new and continuing exploration activity.

We are submitting Bruce Anderson's comments to the U.S. Forest Service and Bureau of Land Management regarding the first proposal to withdraw federal minerals in the Rainy River-Headwaters Watershed from the federal leasing program in Appendix B.[808] We believe that these comments provide an accurate and helpful assessment of noise from exploratory drilling and potential mining in the BWCAW area.

d. Scenic and aesthetic quality impacts in the Birch Lake-South Kawishiwi River entry area would affect the experience of wilderness travelers

The construction and operation of mines in the Rainy River Watershed would introduce levels of noise pollution, vehicular traffic and viewshed impacts incomparable to any activity heretofore existing within the Superior National Forest. While industrial activity itself would not occur in the Wilderness, entering the Wilderness through the national forest is very much a part of the wilderness experience for people who travel long distances from urban areas. Exploratory drilling and other prospecting activities, which present a fraction of the noise, light, and view pollution that would be generated by development of mines along the South Kawishiwi River and Birch Lake, have been incredibly disruptive in the exploration area.[809,810,811,812,813,814,815]

Industrial buildings, a surface waste rock and ore stockpile, conveyer systems, and other mining infrastructure, along with industrial truck traffic and mechanized activity on a 130-foot high tailings pile over a mile-stretch of land, would destroy the atmosphere and primitive quality of the entry to one of the most popular Boundary Waters gateways. The jarring qualities of an industrial mining setting would follow visitors into the Wilderness, and greet them on their way out. Those who know about the degradation of the setting beforehand would not likely choose to travel through this part of the Boundary Waters; the area would become a sacrifice zone to sulfide-ore copper mining. As more than half of the visitors enter the Boundary Waters from entry points in the Kawishiwi Ranger District, this would be a great loss for visitors and for the Wilderness itself.[816]

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805 Reyer, J., & Garwin, R. (2015), *See* Appendix A affidavits testifying to noise caused by exploratory drilling near Birch Lake and experienced inside the BWCAW.
806 Koschak, S.L. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
807 Bollis, G. (2016, Oct. 27). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
808 Anderson, B. (2017, Aug. 17). Comments on Northern Minnesota Federal Mineral Withdrawal EIS.
809 Garwin, R. (2015, Sept. 1). Declaration of Rachel Garwin.
810 *Paddle Flashes* (n.d.).
811 Koschak, S.L. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
812 Koschak, J.S. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
813 Tomsich, L. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
814 Bollis, G. (2016, Oct. 27). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
815 Beymer, R. (2016, Nov. 4) Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
816 Reyer, J., & Garwin, R. (2015), *see* Appendix A (Declaration of Paul Schurke, 2015, July 5.).

e. Degradation of water and the edibility of fish and other natural foods would impact wilderness character

The BWCAW has an abundance of exceptionally clean water, which provides a host of watershed benefits that influence wilderness character, such as sustained surface water and ground water flow, habitats for aquatic and terrestrial plants and animals, recreational opportunities, and microhabitats that sustain biological diversity. Because the Wilderness has waters of exceptionally high quality,[817] wilderness travelers frequently drink directly from BWCAW lakes. The clear, pristine waters of the BWCAW is one of the primary aspects that draws people there. As described above in Part 2, Section A.II., these waters are easily polluted and uniquely vulnerable to sulfide-ore copper mining pollution.

The Wilderness Area is a place "untrammeled by man" and pollution can be defined as a kind of "trammeling." Wilderness should be a place where water and other resources are truly unaffected by human industry,[818] but as explained above, waters of the BWCAW would inevitably be degraded if mining is allowed in its headwaters. As stated in the December 14, 2016 decision letter from USFS Chief Tidwell to BLM,

> Development of the copper sulfide ore mining in the Rainy River Watershed . . . risks seriously impairing the ecosystem health of the wilderness area, and with it, poses unacceptable risks to the wildlife, recreational uses, tribal hunting, fishing, and usufructuary rights, and tourism industry that depend on the pristine nature of the BWCA Wilderness.[819]

The many wilderness travelers who eat fish every day of their visit to the BWCAW should be able to do so without harm. The fact that fish consumption advisories are necessary indicates that wilderness character is already impacted. Consumption advisories caused by mercury and sulfate pollution are discussed in Part 2, Section C.II.g. above.

Sulfate also inhibits growth of wild rice. And heavy metals can also accumulate within terrestrial plant communities, exposing consumers to these toxins. A study done in the vicinity of the Eagle Mine in Michigan show elevated levels of metals in berries within a two-mile radius of emission sources.[820] Arsenic, a toxic heavy metal, is taken up by and stored in rice.[821] Any or all of these impacts could occur in the BWCAW due to upstream or upwind pollution, and would degrade the pristine character of the wilderness. The effects of threats to water quality and the edibility of fish and other natural foods in the Wilderness and Withdrawal Area should be included in environmental review.

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817 MPCA (2017, June). *Rainy River-Headwaters Watershed Monitoring and Assessment Report*

818 *Id.*

819 U.S. Forest Service (2016, Dec. 14). Letter from Tidwell, T., Chief, to Kornze, N., Director, Bureau of Land Management. U.S. Dept. of Agriculture.

820 Superior Watershed Partnership (2018). *Berry and plant tissue monitoring near the Eagle Mine and Humboldt Mill*.

821 Center for Food Safety and Applied Nutrition (2016). *Arsenic in rice and rice products risk assessment report.* U.S. Food and Drug Admin.

f. Impacts on wildlife and ecosystems would also impact wilderness character

Part 2, Section D discusses the likely impacts sulfide-ore copper mining in the Rainy River-Headwaters would have on terrestrial wildlife and ecosystems, including those within the Wilderness Area. Seeing and hearing wildlife and simply existing in a natural ecosystem unaffected by human industry is a large part of what wilderness means to people. Thus, the impact to wilderness character due to degradation of natural plant communities and ecosystems and reduction in the presence of wildlife should be assessed in environmental review.

IV. Mining in the watershed would impact the primitive, near-wilderness character of the Withdrawal Area

The factors that affect wilderness character in the BWCAW will also affect people's recreational experiences in the Birch Lake-South Kawishiwi River area, which as discussed above is an important natural outdoor recreation area in its own right. The proposed Maturi Mine would have significant impacts on this area and would conflict with and degrade the scenic qualities for which Birch Lake's shoreline is managed.[822] The inevitable impacts of the Maturi Mine even if improvements are made to the mine plan include deforestation and land disturbance, degradation of water and air quailty; a decrease in wildlife; and noise, lighting, traffic, and aesthetics. The planned locations of Twin Metals' plant site, tailings management area and tailings facility, and utility corridor, are all within 1,000 feet of the shoreline of Birch Lake. Keeley Creek shoreland also would be affected.

People who live or recreate in this area already find that it is losing its near-wilderness character due to noise from mining exploration. Even with mitigation measures in place, the noise emitted from exploratory drilling, pumping water, bulldozing temporary roads, and helicopter work was life-disrupting, business-disrupting, and recreation-disrupting to business, home, and cabin owners in the Withdrawal Area. Steve and Jane Koschak, the owners of River Point Resort, give an indication of what it might be like to visit or camp in the area with active mines:

> [W]e have been subjected to drilling noise throughout the fall, winter and spring every year for many years. . . . The noise has often been loud and constant enough that we do not open our windows. Whether it is because the birds aren't there or because we cannot hear them over the drilling noise, we did not hear the sound of birds around our property in the spring for several years, from 2006 through 2013. We did not realize how completely the birdsong had been missing during that time until the spring of 2014, after Twin Metals stopped drilling.
>
> When drilling is being done, the noise is constant – day and night. In addition to drilling noise, we heard screeching and banging when drills were being changed, and heavy truck activity. The activity was sometimes close enough to us that we could hear the voices of the workers. We felt captive in our home, as we did not want to be outside in the noise. The whole point of living where we do is lost when we cannot be outside.

[822] U.S. Forest Service (2004, July), Figure MAS-1 "Superior National Forest Management Areas".

> The constant barrage of sound is wearing on us mentally and emotionally; it adds a layer of stress that we would not otherwise experience. This became especially clear to us in 2014 when the noise stopped; the absence of the stress of noise made us realize how much of burden it was. Nonetheless, the stress of living under the threat of losing our business and home to the mining industry is a constant deep dark cloud over us every day.
>
> In the summer of 2013, Twin Metals continued drilling into the summer guest season. This was a significant disruption for our guests, and definitely impacted the quality of their experience here.[823]

Similar experiences with noise disturbance are also documented in the declarations of James Koschak, Gail Bollis, Louis Tomsich, and Rachel Garwin, noted above. In its Record of Decision governing mineral exploration in the Superior National Forest, the Forest Service limited the volume at the boundary of the BWCAW to 30 dBA 50% of the time and 35 dBA 10% of the time.[824] Assuming the limits are being met, mining noise clearly impacts the Birch Lake/South Kawishiwi River area at this level. In the absence of a Withdrawal, the area will be heavily impacted by mining noises that are incompatible with the "Recreation Use in a Scenic Landscape" Management Area classification[825] and the uses that designation is intended to promote and support.

Increased traffic, especially industrial traffic, would also detract from the remote character of the area. Despite being a state highway, Highway 1 is very lightly traveled. Prior to the start of mineral exploration activities, travel in the Birch Lake-South Kawishiwi River area was almost completely limited to recreational traffic and the few residents living there. Driving south, the closest incorporated community is sixty miles away and has less than 2,000 residents. The Federal Highway Administration's level of service rating may not change,[826] but that does not translate to a lack of impact from industrial traffic on recreation and residents.

Another factor that contributes to people's outdoor experience in the Superior National Forest is the clarity of the air and the stunning experience of the night sky. Many people see northern lights for the first time here, and many more are left awe-struck by the stars. This is true for visitors outside the wilderness boundaries as well as wilderness visitors. The light pollution discussed above would degrade the dark sky resource of the Withdrawal Area as well as the BWCAW.[827]

The simple reality is that mining on the scale that is being proposed for the Rainy River-Headwaters watershed is incompatible with outdoor recreation in a natural setting. Mining in this

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[823] Reyer, J., & Garwin, R. (2015).

[824] U.S. Forest Service (2012, May). *Federal hardrock mineral prospecting permits Final Environmental Impact Statement, Cook, Lake, St. Louis, Koochiching Counties, Minnesota*. U.S. Dept. of Agriculture. Attachment 2.

[825] U.S. Forest Service (2004, June). Figure MAS-1 Superior National Forest Management Areas. [Map].

[826] See Twin Metals Minnesota (2019a) lines 6620-22.

[827] Distance calculations were made using Google Earth Pro measurement tools and shapefiles provided to BLM in Twin Metals' 2019 Mine Plan of Operations, available at: https://eplanning.blm.gov/eplanning-ui/project/1503233/590. Distances from the nearest Birch Lake Campground campsite and nearest South Kawishiwi River campsite to Twin Metals' proposed infrastructure are approximately 1.45 miles and 1.25 miles, respectively.

area would eliminate its value for recreation, quiet and serenity, spiritual succor, and simple enjoyment of the natural world. In the BWCAW, the proximity of industrial activity and its attendant sounds, lights, traffic and dust would mean that this part of the wilderness area would no longer be experienced as wilderness. Outside the BWCAW, what is now a beloved recreation area would become an industrial landscape.

V. Sulfide-ore copper mining would destroy recreational amenities in the Withdrawal Area that provide access to the canoe-country experience

The Superior National Forest's dispersed backcountry canoe-camping lakes are a valuable resource, and more important now than ever before. The Forest Service describes them as offering, "camping opportunities similar to that of the Boundary Waters Canoe Area Wilderness with fewer restrictions and no permits required."[828] This resource bolsters the wilderness recreation capacity of the Boundary Waters. Protection of this resource is essential to the region's ability to absorb periodic excess demand for the canoe-country experience.

Demand for the wilderness canoe-camping experience of the Boundary Waters has increased sharply since 2019, with the number of visitors up more than 11% over the previous four-year average.[829] Until measures can improve permittees' knowledge of and compliance with rules and etiquette of the wilderness, or the Quetico Provincial Park is again more accessible, it appears that the number of wilderness entry permits may be reduced.[830] If so, some excess demand for the canoe-country experience will find an outlet in the Superior National Forest's inventory of backcountry dispersed camping lakes and canoe routes.

The Withdrawal Area includes perhaps one-quarter to one-third of the dispersed near-wilderness campsites in the Superior National Forest's total inventory. First and foremost, Birch Lake/South Kawishiwi River area's 16 backcountry dispersed campsites[831] can absorb just about as many backcountry camping groups as Fall Lake, Mud Lake, Ella Hall Lake, and Little Gabbro Lake combined. Other near-wilderness backcountry water access campsites in the proposed Withdrawal Area exist on August Lake, Burntside Lake, Johnson Lake, Bear Island Lake, Norway Lake, Silver Island Lake, and T Lake, among others. Collectively, these routes and backcountry sites offer significant capacity to absorb overflow demand for the Boundary Waters experience. The proposed Withdrawal is essential to protecting this increasingly important resource, including first and foremost the Birch Lake/South Kawishiwi River area, from conversion to an incompatible and destructive use like sulfide-ore copper mining.

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[828] U.S. Forest Service (2008). *Birch Lake Back Country*. U.S. Dept. of Agriculture.
[829] U.S. Forest Service (2021, April 26). *Boundary Waters Canoe Area Wilderness Superior National Forest Permit & Visitor Use Report 2016-2020.* U.S. Dept. of Agriculture.
[830] Helmberger, M. (2021, December 8). USFS to cut BWCA permits. *The Timberjay*.
[831] U.S. Forest Service (2012, Aug. 3) *Canoeing Outside the Boundary Waters*. U.S. Dept. of Agriculture.

F. The U.S. Department of Agriculture and Department of the Interior have a duty to protect the 1854 Treaty Area, and must engage in meaningful government-to-government consultation with the 1854 Treaty Tribes

The U.S. Government has a unique, legal and political relationship with federally recognized Indian Tribes, which is formed by the United States Constitution, statutes, and treaties, as well as by case law and agreements. Each federal agency shares the U.S. Government's trust responsibility to protect and maintain the land, resources, and traditional use areas of Indians.[832,833,834]

The Withdrawal Area, which as noted above is almost entirely naturally vegetated and marked by outstanding natural resources, is encompassed within the 1854 Treaty of LaPointe Ceded Territory, over which the 1854 Treaty Tribes (Grand Portage, Fond du Lac, and Bois Forte Bands of Lake Superior Chippewa) retain treaty rights.[835,836,837,838] The U.S. Department of Agriculture and U.S. Department of the Interior have a duty to protect the 1854 Treaty area including the Withdrawal Area,[839] and must engage in meaningful government-to-government consultation with the Tribes.

G. The area is important for social, cultural, and health-related reasons, which should be assessed and considered

The large-scale development of mining operations brings with it the risk of the many negative social and human health consequences that have affected other mining areas. While these risks are common to many areas facing new mining development, they are particularly inappropriate for the Boundary Waters area. This is one of the most pristine areas -- and possibly *the* most pristine large area -- in the Eastern United States. Many if not most of the people who live or visit here do so for precisely that reason. While Ely may have once been a mining town, those days are more than a half-century in the past. As discussed in Section H. below, the economy is increasingly driven by people who have moved there and to the surrounding townships because of the BWCAW and other natural amenities of the area. It is

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[832] *See, e.g.,* Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 65 Fed. Reg. 67249 (March 14, 2008).
[833] U.S. Department of Agriculture (2008, March 14). *Departmental Regulation No. 1340-007: Policies on American Indians and Alaska Natives*.
[834] Secretary of the Interior & Secretary of Agriculture. (2021, November 15). Joint Secretarial Order #3403 on Fulfilling the Trust Responsibility to Indian Tribes in the Stewardship of Federal Lands and Waters.
[835] Treaty with the Chippewa, 1854, 10 Stat. 1109, in Charles J. Kappler, ed., Indian Affairs- Laws & Treaties, Vol. II (Washington- Government Printing Office, 1904), Art. 1. Retrieved December 31, 2021 via: https://dc.library.okstate.edu/digital/collection/kapplers/id/29627/rec/1
[836] *See*, 1854 Treaty of LaPointe, MN Ceded Territory Map; and see 1854 Treaty Authority's 1854 Treaty Boundary map series in the Appendix, or at: http://www.1854treatyauthority.org/management/biological-resources/fisheries/seasons.html?id=15&task=document.viewdoc
[837] U.S. Forest Service (2016, Dec. 14).
[838] U.S. Forest Service (2021, Sept.). Application for Withdrawal, Superior National Forest, Cook, Lake, and Saint Louis Counties. U.S. Dept. of Agriculture, at p. 4.
[839] Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 65 Fed. Reg. 67249 (March 14, 2008).

unacceptable to expect residents and regular visitors of this area to absorb the social, cultural, and health costs that often accompany the country's most toxic industry.

Birch Lake, which is the approximate location of most of the known mineral deposits in the Withdrawal Area, has a remote quality, but it is in fact as well-used as it could possibly be while still affording people the sense that they are away from society. It is ringed by campgrounds, dispersed campsites, resorts, and seasonal residences. Its water flows into the Boundary Waters Canoe Area Wilderness, the most heavily visited wilderness area in the United States. People are invited here by the U.S. Forest Service, the State of Minnesota, the City of Ely, and the many outfitters, resorts, and camps of the area to experience a pristine environment, and people come from all over the globe to do so. It is completely inappropriate to encourage or accommodate an industry that could negatively affect their health while they are here.

I. Sulfide-ore copper mining in the Withdrawal Area would have negative social impacts

a. Sulfide-ore copper mining in its watershed could result in the BWCAW losing value as wilderness

The Superior National Forest supports a broad spectrum of human recreational, cultural, and economic uses because of its natural amenities. The landscape of forests and water draws visitors as well as seasonal and permanent residents to the area. The entirety of the SNF, including the BWCAW, is open to hunting and fishing and offers a wealth of land- and water-based outdoor recreation opportunities.[840]

Protection of the BWCAW is socially and culturally important to Minnesotans, and to many others as well. For Minnesotans, the BWCAW is a defining natural feature of the state, a point of state pride and, to echo Governor Dayton, a “crown jewel” and a “national treasure.” People from across the U.S. and around the world treasure the clean waters of the BWCAW.[841]

The BWCAW receives 155,000 visitors each year, more than any other wilderness area.[842] More than half of the visitors enter the Boundary Waters from entry points in the Kawishiwi Ranger district. As discussed in Part 2, Section E above, the Birch Lake and South Kawishiwi River area supports a wealth of recreational opportunities and provides a similar experience to the BWCAW to those who do not have the time, financial or material resources, or experience for wilderness travel.

The BWCAW provides one of the best (and certainly the biggest) wilderness freshwater fishing destinations in the country. It is the only wilderness fishing and hunting area of substantial size in the middle of the country. It is also open to trapping under Minnesota state seasons and limits.

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[840] U.S. Forest Service (2005, June). *Superior National Forest recreation niche – “A superior recreation experience.”* U.S. Dept. of Agriculture. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_048974.pdf
[841] Keeler, B.L., Wood, S.A., Polasky, S., Kling, C., Filstrup, C.T., & Downing, J.A. (2015). Recreational demand for clean water: evidence from geotagged photographs by visitors to lakes. *Front Ecol Environ.* doi:10.1890/140124.
[842] U.S. Forest Service (2021, April 26). *Boundary Waters Canoe Area Wilderness Superior National Forest Permit & Visitor Use Report 2016-2020.* U.S. Dept. of Agriculture.

The book "Trapping the Boundary Waters: A Tenderfoot in the Border Country, 1919-1920," by Charles Ira Cook, Jr., is still in print.

Wilderness is important to people. The BWCAW provides both direct experiential and recreational benefits to people who visit it, and indirect benefits to those who look forward to using it or simply cherish its existence. These benefits are explained in "How Wilderness benefits you" at Wilderness.net, a collaborative project between the University of Montana College of Forestry and Conservation, the USDA-Forest Service, the Bureau of Land Management, the National Park Service, and U.S. Fish & Wildlife Service, which concludes:[843]

> [W]ilderness benefits are many and varied. … [I]t's important to remember that those who value wilderness may include not only a devoted trekker who spends weeks of the year in the backcountry, but also a city-dweller who never visits a federal wilderness area in his lifetime.
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> . . .
>
> [R]ecent data from the National Survey on Recreation and the Environment[844] indicate that protecting air quality, water quality, wildlife habitat, unique wild plant and animal species, and benefitting future generations are all consistently rated as the top five most important benefits of wilderness.
>
> Most Americans, both urban and rural, also ascribe high importance to the scenic beauty of wild landscapes, the knowledge that wilderness is being protected, the choice to visit wilderness at some future time, the opportunity for wilderness recreation experiences, preserving nature for scientific study, and spiritual inspiration.

To the extent that these wilderness characteristics are compromised, a wilderness area may lose its value in the eyes of potential visitors and the public at large. Water quality is essential to the wilderness character of the BWCAW, which encompasses activities such as canoeing, fishing, swimming, and drinking water directly from lakes. For many people drawn to the area for its reputation for unparalleled beauty, exceptionally clean water, and "the last great pure experience" touted by the Ely Chamber of Commerce, sulfide-ore copper mining would call into question the purity of the area's water even before contamination occurred. Actual contamination would of course make the problem far worse.

This would be accompanied by the existence of a large industrial district, with its attendant air pollution, traffic, and noise at the doorstep to one of the most popular entry points to the BWCAW. Even under normal development and operating conditions, these industrial mining facilities would fragment and degrade the forest and waters of the area, damaging the ability of federal lands to provide high-quality hiking, scenic, hunting, fishing, berry picking, and other outdoor experiences both within and outside of the BWCAW. The reputation of and visitorship

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[843] Wilderness Connect (n.d.). *How Wilderness benefits you*. http://www.wilderness.net/NWPS/values.

[844] National Survey on Recreation and the Environment (2000-2002). *The Interagency National Survey Consortium*. USDA Forest Service, Recreation, Wilderness, and Demographics Trends Research Group, Athens, GA and the Human Dimensions Research Laboratory, University of Tennessee, Knoxville. https://www.srs.fs.usda.gov/trends/nsre-directory/.

to the BWCAW as a whole would likely be affected.[845] Fewer visits to the BWCAW and BWCAW-edge communities and the diminished attractiveness of the area could result in outmigration of people[846] and other negative effects.[847]

As discussed in Part 2, Section C.II.g. above, increases in mercury and sulfate in the low-sulfate waters of the Withdrawal Area would likely lead to increased mercury methylation and mercury contamination of fish. Existing mercury levels in fish tissue have already led the Minnesota Department of Health to advise people to cut their consumption of local fish, highlighting the choice between reducing subsistence and recreational fish consumption or consuming higher levels of a potent neurotoxin. For the many people who visit the BWCAW or Birch Lake (or the lakes in the path between the two) in part because they so enjoy catching fish and eating their catch, this dilemma can significantly affect their experience.

b. Impacts on the BWCAW would result in the loss of opportunities for personal growth, recovery, and enrichment

The BWCAW offers access to backcountry in ways many wilderness areas cannot. The interconnectedness of lakes, streams, and rivers means that visitors can travel through it by canoe. Routes range from easy to difficult. Water travel allows easy and efficient transport of gear, as compared to backpacking. The comparative ease of movement by canoe allows more extensive trips in less time and with less effort. As the only significant lakeland landscape in the U.S. to be protected as a federal wilderness area, the BWCAW offers unique and unparalleled accessibility to people of a wide range of ages and abilities, from families with small children to people with physical limitations.

The proposed Withdrawal would protect the access to wilderness opportunities for personal growth and leadership development that the Boundary Waters provides. The BWCAW has long been seen and valued as a place for youth to build confidence, self-esteem, enduring memories, and an understanding of the value of nature. Of the 155,000 annual wilderness visitors, many thousands are on their first Boundary Waters trip – both youth and adults. Thousands of youth go on their first Boundary Waters trip each year.

The Girl Scouts' only wilderness base camp in the nation is on the outskirts of Ely, on Fall Lake. The Northern Tier High Adventure Base, the Boy Scouts' "gateway to adventure in the Great Northwoods," has its flagship Wilderness base, the Charles L Sommers Canoe Base on Moose Lake at the edge of the BWCAW, near Ely, Minnesota. The Sommers Base, which was established in 1941, outfits over 4,000 scouts each year on wilderness canoe trips in the

[845] Many people do not distinguish between the different HUC-11 watersheds in the BWCAW, but see it as a whole, and the perception of the BWCAW as a whole would be forever tarnished by sulfide-ore copper mining in the BWCAW watershed.
[846] Sungur, E., Asche, K., Fluegel, D., Ronnander, R., & Bibeau, J. (2014, January 2). *The Four Townships Area Economic, Housing and Development Survey*. University of Minnesota, Morris.
[847] Phillips, S. & Alkire, C. (2017). *Sulfide-ore copper mining and/or a sustainable Boundary Waters economy: The need to consider real tradeoffs.* Key-Log Economics. Prepared for Northeastern Minnesotans for Wilderness.

BWCAW and Quetico Provincial Park.[848] The YMCA also has four wilderness camps in the area.

Voyageurs Outward Bound School (VOBS), which has been located on the South Kawishiwi River (in the Withdrawal Area) since 1964, is one of eleven schools in the Outward Bound network, an international educational non-profit founded in 1941. VOBS serves troubled youth, people with disabilities, and military veterans, among other populations. For the people VOBS serves, a wilderness paddling trip can be a means to healing, personal confidence and leadership skills development, and social skills development, as well as a memorable introduction to the Boundary Waters itself.[849,850,851]

VOBS, whose mission is "changing lives through challenge and discovery," has been hosting and delivering, tuition- and travel expense-free, wilderness expeditions in the BWCAW for veterans and active duty service members who have deployed to combat areas. One such VOBS course was offered to veterans of the Marines "Forgotten Battalion,"[852] which as Jack Lee, the head of VOBS relates, "was specifically directed to VOBS not only because of our reputation of healing and empowerment but also because of the Boundary Waters' unique, calming environment, and the fact that survival in the wilderness requires perseverance and commitment."[853] Military veterans have found that time spent in the BWCAW helps in transitioning from combat service, and provides access to healing, reconnection, and peace after wartime experiences.[854,855] For some, the BWCAW changed and may have saved their lives.[856]

In addition to other organizations that provide trips for personal development, healing, and recovery, many people have found their way to the BWCAW on their own or through family and friends, and count it as critical to their own personal growth. These people are supported by, and in turn support the more than 30 outfitters, resorts, campgrounds, camps, and other wilderness-oriented businesses that are located on the South Kawishiwi River, Birch Lake, and lakes between there and the Fall Lake entry to the Boundary Waters. The loss of these businesses would in turn be a loss to many wilderness visitors. If mining is allowed in the watershed, one

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[848] Northern Tier High Adventure (n.d.). *Ely, MN base - Charles L. Sommers canoe base.* Boy Scouts of America. https://www.ntier.org/expeditions/summercanoetreks/ely-2/.
[849] Lee, J. (2016, Nov. 4). Affidavit [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
[850] Lee, J. (2019, Jan. 10). Declaration. [Filing in *Voyageur Outward Bound School v. U.S.*, U.S. Dist. Ct. (D.C. Dist.) Case 1:18-cv-01463-TNM].
[851] Packard, E.R. (2016, Oct. 18). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
[852] Phillips, D. (2015, Sept. 9). In unit stalked by suicide, Veterans try to save one another. *The New York Times.* https://www.nytimes.com/2015/09/20/us/marine-battalion-veterans-scarred-by-suicides-turn-to-one-another-for-help.html.
[853] Lee, J. (2016, Nov. 4), p. 4.
[854] Reyer, J., & Garwin. R. (2015). The Impacts of Mining on the Character of a Wilderness Landscape: Considerations for Federal Decision-Making.
[855] Vella, E.J., Milligan B., & Bennett J.L. (2013). Participation in Outdoor Recreation Program Predicts Psychosocial Well-Being Among Veterans with Post-Traumatic Stress Disorder: A Pilot Study. *Military Medicine, 178*(3), 254-60. https://doi.org/10.7205/MILMED-D-12-00308.
[856] Packard, E.R. (2016, Oct. 18).

such loss would be the River Point Resort & Outfitting Company, which is located at the confluence of Birch Lake and the South Kawishiwi River.[857,858,859]

c. Fishing, hunting, and ricing are important to Minnesotans and would be affected by sulfide-ore copper mining

The potential impact of sulfide-ore copper mining on fish, wildlife, and wild rice are described in other sections of these comments. It is important to understand that fishing, hunting, and gathering wild rice are important activities for many people in Minnesota.

More than one in five Minnesotans bought a fishing license in 2021.[860] In a survey of residents of four townships near Ely, Minnesota, 41% said they engage in fishing on public lands. Twenty-six percent of respondents said they sustain their family in part by hunting, fishing, or gathering.[861] In a state known for great fishing, the BWCAW is a premier fishing destination

d. Mining boom-and-bust cycles would have negative social impacts

The Forest Service should also consider the negative social and socio-economic effects of the boom-and-bust economic cycles that often accompany mining. In addition, the long-term decline in the amount of labor required to produce metal contributes to these effects.[862] Metals are globally traded commodities with highly unstable prices, which can result in extremely unstable economic situations for the communities that depend on mines.[863]

As MDNR stated in its economic assessment for the NorthMet project, "Though this 'boom and bust' phenomenon is often present in mining communities . . . the duration of a boom or bust and the severity relative to modeled commodity prices cannot be predicted."[864] It is this very unpredictability that makes the phenomenon so difficult. Unpredictability of employment and income is hard on individuals, families, and communities. During good times, the greater availability of money and spending can result in local economic distortions (e.g., inflation of the local housing market and more frequent large purchases), which can leave individuals and families in economic duress when downturns hit. Canadian researchers at the University of British Columbia Institute of Mining Engineering and School of Population and Public Health have documented increases in pregnancies, sexually transmitted infections, and mine related

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[857] Koschak, S.L. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
[858] Koschak, J.S. (2016, Oct. 26). Declaration. [Filing in U.S. Dist. Ct. (Minn.) No. 16-CV-3042 (SRN/LIB)].
[859] Koschak, S.L. (2019, March 5). Declaration. [Filing in *Voyageur Outward Bound School v. U.S.*, U.S. Dist. Ct. (D.C. Dist.) Case 1:18-cv-01463-TNM].
[860] U.S. Fish and Wildlife Service (2021). National Fishing License Data - Calculation year 2021. U.S. Dept. of the Interior. (U.S. FWS data show Minnesota residents purchased 1,238,367 fishing licenses in 2021. According to the 2020 census, Minnesota's population is 5,706,494) https://www.census.gov/library/stories/state-by-state/minnesota-population-change-between-census-decade.html
[861] Sungur, E., Asche, K., Fluegel, D., Ronnander, R., & Bibeau, J. (2014, January 2).
[862] Power, T.M. (2007). *The Economic Role of Metal Mining in Minnesota: Past, Present, and Future*. Prepared for Minnesota Center for Environmental Advocacy and the Sierra Club.
[863] United States Congress, House Committee On Interior And Insular Affairs, Subcommittee On Mines And Mining (1979). *Nonfuel minerals policy review: oversight hearings.* Ninety-sixth Congress, first-second session. Retrieved Aug. 10, 2017, from https://lccn.loc.gov/80601095
[864] NorthMet FEIS p. 5-578.

injuries during mining boom times; and burdens to health and social services, and mental health issues such as depression and anxiety, during bust times. Community health issues during boom and bust periods include family stress, violence toward women, and addiction issues.[865]

Boom and bust cycles are more likely in areas mining low-grade ore. During times when metal prices are high, lower grade deposits (with narrower profit margins) are brought on line. Lower-grade deposits are then more likely to be idled when prices fall. As discussed in Part 2, Section A.II.h.2. above, Duluth Complex ores will be low-grade, and Duluth Complex mines are likely to be economically marginal. Siting mines in this area therefore presents high risk of economic disruption to local communities.

The need for increased services and infrastructure in towns with fluctuating populations and employment can also be extremely difficult for local governments. The 1979 Minnesota Regional Copper-Nickel Study "included detailed modeling of the impact of copper development on the fiscal balance of local governments and concluded that the new tax revenues would not come close to covering the costs of providing the additional services to residents and businesses."[866]

e. Establishment of a mining district would affect historic, prehistoric, and cultural sites

The Withdrawal Area has been used by people for some 10,000 years and is home to a number of prehistoric and historic sites. One such known site is the Laurel Indian Village site at the southernmost point of land at the confluence of the South Kawishiwi River and Birch Lake.[867] Undoubtedly there are many other sites, known and unknown. The USFS should review materials in its possession and consult with the State Historic Preservation Office and Tribal Historic Preservation Officers.

f. The BWCAW in its pristine state is important to scientific research

The Forest Service should consider the significance of the BWCAW as a landscape-scale science laboratory and location for long-term ecological research, and the impact that sulfide-ore copper mining would have on this outdoor laboratory. Damage to the BWCAW by disruption and contamination in its watershed would affect decades of existing baseline research, which would interfere with long-term studies. This would be an enormous loss to society and to science.

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[865] Shandro, J.A., Veiga, M.M., Shoveller, J., Scoble, M., & Koehoorn, M. (2011). Perspectives on community health issues and the mining boom-bust cycle. *Resources Policy, 36,* 178–186. doi:10.1016/j.resourpol.2011.01.004.
[866] Great Lakes Indian Fish and Wildlife Commission (2016). *Metallic mineral mining: The process & the price*.
[867] Harrison, C. (1985). *The archaeology of two lakes in Minnesota*. U.S. Dept. of the Interior, Bureau of Land Management. (Report on excavations at archaeological site 21-SL-165, St. Louis County, Minnesota, performed during October 1983 and June 1984).

Wilderness is essential to human understanding of the natural world we inherit.[868] At a 1999 conference on the scientific significance of wilderness, more than 36 papers were presented on the theme of wilderness as a place to conduct scientific research.[869]

The volume of scientific studies and related published papers confirms the BWCAW's value as an outdoor laboratory for scientific inquiry and as a place for education spanning a wide range of biophysical and social science topics.[870] These include the study of the patterns and processes of terrestrial and aquatic ecosystems; the isolation of baseline conditions at landscape scales for studying and differentiating environmental changes, their sources, and their significance; and to aid "the general public's understanding of natural environments and the ecological problems facing mankind."[871]

One benefit of a wilderness area as large and intact as the BWCAW is that it provides a baseline for similar ecosystems that have been affected by human activity. The BWCAW is known in the world scientific community as a long-standing source of groundbreaking landscape-scale ecological research. BWCAW-based research – on forest fires, landscape patterns and processes, biodiversity, wildlife, soils, nutrient cycling, and many other aspects of intact landscape ecosystems – has been cited by scientists around the world.

According to Google Scholar, [Myron] Heinselman's classic research on forest fires published during the 1970s-1990s has been cited in more than 1,700 subsequently published studies. Recent BWCAW-related studies by Frelich and [Peter] Reich and colleagues at the University of Minnesota (1995 to date) have been cited by more than 1,300 subsequently published studies in 70 peer-reviewed science journals published in 20 countries on four continents. New results from the BWCAW research are regularly presented at prestigious international meetings of scientific societies.[872]

Further evidence of the importance of the BWCAW as a research laboratory can be found in a review the bibliographies of University of Minnesota Professors Peter Reich, Lee Frelich, Roy Rich, and Cliff and Isabel Ahlgren, and the research papers produced over the decades by the U.S. Forest Service, U.S. Geological Survey, Minnesota Department of Natural Resources, and other government agencies.

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[868] McCool, S. F. & Cole, D.N. (1999). Preface. In U.S. Forest Service (1999). *Introduction to wilderness science in a time of change conference proceedings, Vol. 3: Wilderness as a place for scientific inquiry*. U.S. Dept. of Agriculture.

[869] U.S. Forest Service (1999). *Wilderness science in a time of change conference, Volume 3: Wilderness as a place for scientific inquiry*. U.S. Dept. of Agriculture.

[870] Superior National Forest (n.d.c). *Research on the Superior National Forest*. U.S. Forest Service, Dept. of Agriculture. Retrieved on Nov. 29, 2021 from https://www.fs.usda.gov/detail/superior/landmanagement/?cid=STELPRDB5353934

[871] Heinselman, M.L. (1973). Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. *Quaternary Research*, *3,* 329-382. 10.1016/0033-5894(73)90003-3.

[872] Frelich, L. (2014, Feb. 19) Letter to Becky Rom.

II. Sulfide-ore copper mining can impact human health

Common pollutants from sulfide-ore copper mining have been identified in government reports, medical articles, and peer-reviewed scientific publications as sources of harm to physical and mental health. According to the University of Arizona's Superfund Research Program, in Arizona (which produces 65% of U.S. copper), "Many times [nearby] communities are exposed to poor air quality, contaminated water, and occupational hazards. In general, the occupational health and safety risks are above average for the mining industries. Such risks can include chronic occupational diseases which can be a result of direct exposure to dust during metal/mineral extraction."[873]

The EPA has reported that the metal mining industry is the largest toxic polluter in the nation, releasing 3.4 billion pounds of toxins in 2000, or 47 percent of the total released by all U.S. industries combined.[874] Five sulfide-ore copper-nickel mining pollutants – mercury, lead, arsenic, asbestos-like fibers, and particulate matter – are among the ten chemicals listed by the World Health Organization as being of major public health concern, [875] as pointed out by Duluth-area medical professionals in a 2016 Minnesota Medical Association Journal article.[876]

It is due to these and other health risks that an unprecedented level of concern has been voiced by health professionals and advocates, including the Minnesota Medical Association, the Minnesota Academy of Family Physicians, Minnesota Nurses Association, Minnesota Public Health Organization, and hundreds of individual healthcare providers who submitted letters in response to the NorthMet EIS.[877,878]

a. Community health would likely be affected by sulfide-ore copper mining

A group of these doctors reiterated their concerns in February 2018, asking that any consideration of sulfide-ore copper mining in the Boundary Waters watershed include a health assessment. In addition to other health issues discusses herein, they expressed concerns about community health:

> It is also recognized by research that 60% of our health is determined by environmental and social conditions and behaviors, referred to in public health as the social determinants of health. Assessment of the risks and costs of disrupting this sensitive and unique region

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[873] Superfund Research Center (n.d.). *Copper Mining and Processing: Copper Mining in AZ and Tribal Lands*. University of Arizona. https://superfund.arizona.edu/resources/modules/copper-mining-and-processing/copper-mining-az-and-tribal-lands.

[874] Office of Inspector General. (2004). *Nationwide Identification of Hardrock Mining Sites*. [Report No. 2004-P-00005]. U.S. EPA.

[875] World Health Organization (n.d.) *10 chemicals of public health concern*. Retrieved on June 1, 2020 from https://www.who.int/news-room/photo-story/photo-story-detail/10-chemicals-of-public-health-concern

[876] Onello, E., Allert, D., Bauer, S., Ipsen, J., Saracino, M., Wegerson, K., Wendland, D., & Pearson, J. (2016). Sulfide Mining and Human Health in Minnesota. *Minnesota Medicine*. *Nov./Dec*, 51.

[877] Allert, D. (2015, Nov. 11). Medical professionals' view: Minnesota medical professionals call for PolyMet health-impact assessment. *Duluth News Tribune*.

[878] Rome, J.D., Piepgras, D.G., et al. (2016, May 5). Letters to Members, MN Congressional Delegation.

of our state is imperative for inclusion. These risks/costs would include but would not be limited to:

- The loss of wellness that will result if communities around the Boundary Waters were to transition from communities which serve as the gateway to pristine wilderness to communities which are a gateway to large industrial mine sites.
- The cost of erosion of the pristine wilderness that has sustained an outdoor recreation industry in Minnesota that contributes to a stable tax base, jobs in a range of sectors, and the retention and talent and wealth locally as well as in greater Minnesota.
- The cost of the erosion of the pristine wilderness that serves as a source of mental and spiritual health, healing, and rehabilitation not only for the local region, but for countless individuals across our state and nation who utilize this region.
- Noise pollution to surrounding wilderness and loss of serenity that this wilderness provides to utilizers as well as local residents.
- The cost for health care, special education, loss productivity resulting from potential human health impairments.
- The cost and capability of increasing mental health providers in this region to meet increasing needs, a region that currently has an inadequate number of mental health professionals and facilities to meet even its current needs.[879]

Overarching social issues accompanying the boom-bust cycle of mining are discussed in the previous subsection above, and should also be considered as threats to public health and safety associated with sulfide-ore copper mining.

b. Airborne pollutants pose a risk to human health

Sulfide-ore copper mining activities generate rock dust that includes heavy metals, mineral fibers, and particulate matter. Other emissions from mining operations include heavy equipment exhaust, power supply emissions, and ore processing gasses that can contribute to increased morbidity and heightened risk of stroke, cardio-pulmonary disease, and more. Exposure to heavy metals can lead to kidney damage, long-term neurological effects on intelligence and behavior, developmental retardation, cancer, and autoimmune illnesses. Airborne pollutants can travel beyond a mine site to affect local residents and visitors.[880,881,882]

[879] Ipsen, J., Pearson, J., Sutherland, S. & Wegerson, K. (2018, Feb. 19). Letter to Cummins, C., Supervisor, Superior National Forest.
[880] Boulanger, A., & Gorman, A. (2004). *Hardrock mining: Risks to community health.* Women's Voices for the Earth.
[881] Shi, L., Zanobetti, A., Kloog, I., Coull, B.A., Koutrakis, P., Melly, S.J., & Schwartz, J.D. (2016). Low-concentration $PM_{2.5}$ and mortality: Estimating acute and chronic effects in a population-based study. *Environmental Health Perspectives, 124*, 46–52. http://dx.doi.org/10.1289/ehp.1409111.
[882] Franklin, B.A., Brook, R., & Pope, C.A. (2015). Air Pollution and Cardiovascular Disease. *Current Problems in Cardiology, 40*, 207–238. http://dx.doi.org/10.1016/j.cpcardiol.2015.01.003.

Both Duluth Complex sulfide ores and Mesabi Range taconite ores contain elongated mineral fibers[883] that bear similarities to asbestos and may cause or contribute to mesothelioma and lung cancer.[884,885,] The Minnesota Taconite Workers' Health Study showed elevated incidences of mesothelioma (200% greater than the general population), lung cancer (20% greater) and heart disease (11% greater) among Minnesota miners. [886] High levels of airborne mineral fibers from mining emissions have been a concern for the Babbitt and Silver Bay communities for many years,[887,888] and levels will almost certainly increase with the development of new mines.[889,890]

c. Water pollution from sulfide-ore copper mining poses a risk to human health

As discussed in Part 2, Section C.II.g. above, sulfide-ore copper mining would likely increase the level of mercury in fish tissue. Consuming methylmercury poses risks to human health.[891,892,893,894] Mercury in fish tissue is a global problem that is particularly pronounced in northern Minnesota. A 2011 study done by the Minnesota Department of Health found that 10% of the newborns in the Minnesota portion of the Lake Superior basin have blood methylmercury levels high enough to affect neurological development.[895] Highest concentrations were measured in summer births, which supports the hypothesis of local fish consumption as an important factor. While a similar study has not been done of the Rainy River watershed, the geography, geology, ecology, and cultural practices of these adjacent watersheds are the same, and thus similar findings would be expected.

The U.S. EPA is currently planning to reassess the RfD for chronic oral exposure to methylmercury through its Integrated Risk Information System (IRIS) program. Traditionally, studies of methylmercury exposure impacting human heath have focused on neurodevelopmental issues. However, IRIS plans to more thoroughly examine the cardiovascular impacts of

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[883] Stevenson, R.J. (1978). *Regional Copper-Nickel Study: Concentrations of Mineral Fibers in Process Samples from Northeast Minnesota.* Minnesota Environmental Quality Board.
[884] Ring, S.J. (n.d.). Expert Opinion of Steven J Ring.
[885] Cook, P.M., Swintek, J., Dawson, T.D., Chapman, D., Etterson, M.A., & Hoff, D. (2016). Quantitative structure-mesothelioma potency model optimization for complex mixtures of elongated particles in rat pleura: A retrospective study. *Journal of Toxicology and Environmental Health, Part B*, *19,* 5-6, 266-288. http://dx.doi.org/10.1080/10937404.2016.1195326.
[886] Finnegan, J.R. (2014). *Final Report to the Legislature Minnesota Taconite Workers Health Study*. University of Minnesota School of Public Health. Minneapolis, MN.
[887] MPCA (2007a). Ambient air monitoring spreadsheet. [Excel spreadsheet]. (Silver Bay and Beaver Bay data provided by MPCA to Le Lind of Save Lake Superior Association on Jan. 24, 2007.)
[888] Minnesota Dept. of Health (2008, Sept. 30). Environmental laboratory reports of analytical results, MPCA air quality request 336652. (Babbitt data).
[889] Stevenson, R.J. (1978).
[890] NorthMet FEIS 5-517.
[891] Ipsen, J., et al. (2018, Feb. 19).
[892] Great Lakes Indian Fish and Wildlife Commission. (2016). *Metallic mineral mining: The process & the price.*
[893] Trasande, L., Landrigan, P.J., & Schechter, C. (2005). Public health and economic consequences of methyl mercury toxicity to the developing brain. *Environmental Health Perspectives*, *113*, 590-596. doi:10.1289/ehp.7743.
[894] Integrated Risk Information System (n.d.). *Methylmercury (MeHg); CASRN 22967-92-6*. U.S. EPA. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0073_summary.pdf.
[895] McCann, P. (2011). *Mercury Levels in Blood from Newborns in the Lake Superior Basin.* Minnesota Department of Health.

methylmercury consumption within its reassessment, since more recent studies have linked health events like increased coronary events, heart disease, and cardiovascular disease to methylmercury exposure.[896]

Many visitors to the BWCAW – including children and women of child-bearing age – rely on the fish they catch to feed themselves during their wilderness trip. This is an important aspect of the wilderness experience for many people. For children and women who are or may become pregnant, the Minnesota Department of Health already advises limiting consumption of walleye and northern pike from many lakes to one meal per month.[897] This issue also already affects residents of the area. Increasing mercury in fish must be treated as a significant impact of sulfide-ore copper mining in the watershed.

In addition to mercury, potential heavy metal contaminants from mining in the Duluth Complex include arsenic, cadmium, cobalt, copper, lead, manganese, nickel, selenium, and zinc.[898] Arsenic and cadmium are both classified by the EPA as carcinogens, and lead is classified as a probable carcinogen.[899] These metals are commonly released by sulfide-ore copper mining.[900] Human consumption of various metals has been linked with increased risk of lung, skin, bladder, liver, kidney, and prostate cancer; damage to blood vessels; damage to kidney and liver; skin damage; neurodevelopmental impacts like behavioral disorders and learning disabilities and impairment of fine-motor functions; and cardiovascular impacts like coronary events and heart disease.[901]

Acid mine drainage and other releases of heavy metal pollutants poses a threat to drinking water sources downstream of potential mines. Many northern Minnesota residents get their drinking water through personal wells or from surface waters. In the Withdrawal Area, releases would pose a threat to Birch Lake and downstream waters, including BWCAW waters, which are commonly used by wilderness travelers to drink, cook, and clean. People who eat wild rice harvested from waters in the path of pollution may be exposed to unhealthy arsenic levels.[902,903]

The failure of Minnesota regulatory agencies to conduct health risk assessments before permitting mines rests on the assumption that pollutants will not escape to the environment

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[896] Integrated Risk Information System (n.d.).
[897] Minn. Dept. of Health. (2020, Feb.). *Fish consumption guidance.* https://www.health.state.mn.us/communities/environment/fish/#statewide. *See* Statewide safe-eating guidelines – pregnant women, women who could become pregnant, and children under age 15.
[898] PolyMet Mining Co. (2015, Feb. 27). NorthMet Project water modeling data package – Vol. 1, mine site. (NorthMet FEIS ref. doc. PolyMet 2015m), App. G.
[899] Center for Science in Public Participation (n.d). *Health and environmental effects of trace elements in metal-mining wastes.* http://www.csp2.org/files/reports/Fact_Sheets--Trace_Elements_in_Mining_Waste.pdf
[900] U.S. EPA (1995, Dec). *Human health and environmental damage from mining and mineral processing wastes.* https://archive.epa.gov/epawaste/nonhaz/industrial/special/web/pdf/damage.pdf.
[901] World Health Organization (2010). Ten chemicals of public health concern.
[902] Brooke, L., Polkinghome, C.N., Saillard, H.J., & Markee, T.P. (2004). *Metal concentrations in wild rice roots and seeds, mollusks, crayfish, and fish collected from various Wisconsin water bodies in autumn of 2003*. Lake Superior Research Institute, University of Wisconsin-Superior. Superior, WI.
[903] U.S. Food and Drug Administration (2016). *Arsenic in rice and rice products risk assessment report*. U.S. Department of Health and Human Services.

through either air or water at high enough levels to affect human residents and visitors.[904] For the many reasons discussed in previous sections of these comments, this assumption is highly uncertain. While it cannot be known ahead of time how unanticipated releases of pollutants will occur and at what level, such occurrences are virtually certain. Mining operations should not be allowed to proceed without a clear understanding of the risks of potential releases to human health.

H. The mineral Withdrawal would benefit the local and regional economy

Amenity-based development is the economic engine of the Arrowhead region.[905] While steps are being taken to improve the economy of wilderness-edge communities,[906] it is already diversified and steadily growing, and not subject to the harms of boom & bust cycling seen in Iron Range communities. The region has had a stable to slowly growing population since 1989, and in stark contrast to most rural portions of Minnesota, added population overall since 2010. The BWCAW and near-wilderness zone around it form the principal and most distinctive natural asset of the region.

In the environmental review, the Forest Service should consider how the proposed Withdrawal would protect and strengthen the existing economy, and would prevent the harms that would come to the economy if the watershed is instead opened to sulfide-ore copper mining. Such mining would injure the environmental quality and reputation of the BWCAW as well as wilderness-edge areas that host significant recreation activity. Degradation of the amenities that bring both visitors and residents to the area would ultimately cost the larger Ely area in terms of jobs, income, and quality of life.

I. Amenity-based economies attract wealth and economic activity through the residents and visitors drawn to the place or region by its natural amenities

The distribution of natural amenities helps explain population trends in rural counties that cannot be explained by other factors. Over time, communities rich in distinctive, high-quality amenities such as access to nearby wilderness areas and protected lands often develop economic activity not found in areas lacking such amenities.[907,908] These communities are said to have amenity-based economies.[909]

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904 The one type of health risk assessment that is done -- assessment of the risk of toxic air emissions -- assesses only the impacts of expected emissions. The risk from higher levels of pollutants than expected is not addressed. *See* NorthMet FEIS, p. 5-497.

905 Phillips, S. (2015). *Boundary Waters Canoe Area - wealth generator*.

906 Vandervort, K. (2021, December 8). Ely economic developers wrap up a busy year. *The Timberjay.*

907 Holmes, T.P., Bowker, J.M., Englin, J., Hjerpe, E., Loomis, J.B., Phillips, S., & Richardson, R. (2015). A synthesis of the economic values of wilderness. *J. Forestry, May 2016 114(3)*, 320-328. http://dx.doi.org/10.5849/jof.14-136.

908 Rasker R., Gude, P.H., & Delorey, M. (2013). The effect of protected federal lands on economic prosperity in the non-metropolitan West. *Journal of Regional Analysis & Policy, 43,* 110-122.

909 McGranahan, D.A. (1999). *Natural amenities drive rural population change.* Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture.

> Amenity-based development is economic activity in a host of industries, including recreation/tourism, construction, personal and professional services, retail, and others that arrives or stays in a region for the sake of its scenic, recreational, environmental, and quality-of-life amenities. These amenities induce an in-migration (and support the retention) of human capacity (entrepreneurs, skilled workers) that is the real engine of economic development. Amenities also attract and retain consumers, including retirees and working-age people who could do their jobs anywhere, but who would prefer to live in a place with a high quality of life.[910]

The trend toward remote work has been growing for years, but the COVID-19 pandemic has resulted in an accelerated shift toward remote work, handing more people expanded flexibility to retain their jobs while relocating to more desirable locations.[911] Many factors influence such choices, but all else being equal, those who are most mobile will choose to live nearer to high-quality natural amenities.[912]

Highly attractive natural amenities can reduce or even reverse the rate of population loss that has been seen throughout rural and mostly rural areas in recent decades, such as the 11.5% population loss in rural Minnesota between 2010 and 2019.[913] Damage to, or the threat of damage to, a region's amenities will reduce the region's capacity to attract and retain a portion of the increasing share of the modern economy comprised of mobile workers and retirees.[914]

II. The Forest Service should assess the existing economy of the Arrowhead region, including the role of natural amenity-based businesses and the economic benefits of protecting the Withdrawal Area and the Boundary Waters

a. Mining has declined in economic significance in northeastern Minnesota in recent decades

Compared to the 1970s, northeastern Minnesota's economy is much less dependent upon taconite mining despite the industry's retention of its taconite production capacity. Since 1979, the region's taconite mining and pellet-making industry has been hit by a series of downturns.[915] In 1970 the industry employed 10% of the region's workers and accounted for 15% of the region's wage income,[916] but by 2019 it employed only 3.0% of the region's workers

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[910] Phillips, S., & Alkire, C. (2017). *Sulfide-ore copper mining and/or a sustainable Boundary Waters economy*.
[911] Brown, J.P., & Tousey, C. (2021). *How the pandemic influenced trends in domestic migration across U.S. urban areas.* Federal Reserve Bank of Kansas City (forthcoming in Economic Review).
[912] Phillips, S., & Alkire, C. (2017).
[913] *A demographic profile of rural Minnesota in comparison with Minnesota*. (2021). Created with Headwaters Economics' Economic Profile System, p. 4. Retrieved Nov. 28, 2021 via: https://headwaterseconomics.org/apps/legacy-economic-profile-system/.
[914] Phillips, S., & Alkire, C. (2017).
[915] The biggest bust played out over an eight-year period, when Minnesota employment in iron mining fell in a series of steps from more than 13,200 workers in 1979-80 to 4,546 in 1988. The boom in 1989-1991 recovered just 1,922 of the more than 8,700 jobs mining lost in the 1980s. Likewise, the boom in 2010-2014 recovered just 1,754 of the 3,400 jobs lost in the 1997-2009 bust. *See* Harbin, D (2020), below.
[916] Phillips, S., & Alkire, C. (2017).

and accounted for just 3 to 4% of the region's wage income.[917,918] Despite the industry's elimination of most of the mine and pellet plant jobs, production capacity trend lines for the industry have held steady (with significant year-to-year fluctuations); worker productivity (tons of pellets shipped per worker) has more than doubled, from 3,605 tons/worker in 1975, to 9,420 tons/worker in 2019.[919] Continued mechanization and automation in the boom and bust context are driving a consistent trend in which the taconite industry provides a steadily declining job and wage base to northeastern Minnesota.

b. The existing Arrowhead regional economy is succeeding as an amenity-based economy

The three-county Arrowhead region of northeastern Minnesota has a diversified, diversifying, and growing natural amenity-based economy, especially in the wilderness gateway communities, such as Ely and the surrounding four townships. The prime natural amenities of the area (the BWCAW, the Withdrawal Area, and the clean water that ties them together,[920]) attract visitors from across and beyond Minnesota and the United States.[921] Visitors and seasonal residents pass through and spend money in wilderness-edge businesses and communities in pursuit of what the Ely Chamber of Commerce calls, "the last great pure experience."[922]

More than 165,000 permitted backcountry visitors entered the BWCAW in 2020,[923] bringing economic activity to the region. Even as other portions of the economy slowed from the disruptions of the pandemic, Ely and other gateway communities saw enormous increases in visitation, with some businesses reporting 20-25% increases in business, year over year.[924] Additional people flock every year to wilderness-edge resorts, campgrounds, backcountry campsites, and even houseboat rentals on scenic lakes in the Withdrawal Area, such as in the Birch Lake/South Kawishiwi River area.[925] As discussed in Part 2, Section E.V. above,

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917 *A profile of socioeconomic trends - St. Louis County, Lake County, and Cook County, MN* (2021). Created with Headwaters Economics' Economic Profile System. Retrieved Nov. 27, 2021 from https://headwaterseconomics.org/apps/legacy-economic-profile-system/. Pp. 16 (135,733 total jobs in the three-county region in 2019); 24 ($7,374,142,000 total labor earnings in the three-county region in 2019).

918 Harbin, D. (2020). *The annual report of the inspector of Mines 2019. St. Louis County, Minnesota*. Retrieved December 13, 2021 from https://www.leg.mn.gov/docs/2020/mandated/200576.pdf (All taconite mines in the region are in St. Louis Co. In 2019, 4,105 people were employed in taconite mines and mills, working a total of 8,517,320 hours; multiplying total hours by the minimum and maximum pay scales gives upper and lower bounds for total mining wages in 2019 of $220,768,934 to $297,084,121.)

919 *Id.*

920 Keeler, B.L., Wood, S.A., Polasky, S., Kling, C., Filstrup, C.T., & Downing, J.A. (2015). Recreational demand for clean water: evidence from geotagged photographs by visitors to lakes. *Front Ecol Environ.* doi:10.1890/140124..

921 Phillips, S. (2015).

922 Pearson, E. (2018, June 13). Small Minnesota towns turn to branding agencies to 'save' their cities. *StarTribune*.

923 Seitz, G. (2021, May 4). 2020 Boundary Waters visitor numbers up significantly. *Quetico Superior Wilderness News*

924 Kraker, D. (2021, April 29). Pandemic-fueled surge in visitation to BWCA expected to continue this year. *Minnesota Public Radio* story printed in the *Mesabi Tribune*. Retrieved December 14, 2021 via: https://www.mesabitribune.com/free_press/pandemic-fueled-surge-in-visitation-to-bwca-expected-to-continue-this-year/article_e07e90ea-a943-11eb-965b-fb2877807a0a.html#//

925 Wolfe, J. (2020, Jan. 6). Premier Outdoor Recreation Area, or a Mining District? 30 Shoreline Recreation Businesses on the Path of Pollution. [Map]. Northeastern Minnesotans for Wilderness.

backcountry camping and canoeing opportunities in the Withdrawal Area are becoming even more important as use of the wilderness itself increases. The more easily accessible areas of the wilderness are reaching capacity in terms of numbers of visitors; if backcountry recreational areas in the Withdrawal Area lose their backcountry character, the result will ultimately be fewer visitors coming to the area, because other parts of the BWCAW cannot absorb visitors who in the past would have gone to the Birch Lake/South Kawishiwi River area.

The same natural amenities help retain existing residents and attract new ones to wilderness edge communities like Ely and the four nearby townships, the broader Arrowhead region of northeastern Minnesota, and Minnesota generally. The economic significance of year-round and seasonal residents who can live wherever they choose, and choose to live in the Arrowhead region cannot be overstated.[926] The knowledge, professional skills, jobs, incomes, businesses and entrepreneurialism, retirement savings, and general economic participation they bring with them have diversified and fueled the economy of northeastern Minnesota.[927]

The region's socioeconomic measures have improved substantially over a 1970 benchmark. After a 9% drop in population between 1979-1988, the Arrowhead region's population stabilized in 1988 and has been stable or growing since 1989.[928] From 1970 to 2019, total Arrowhead region employment grew 42%, with the number of wage and salary workers up 31% and proprietors up 145%. Total personal income increased 86% in the same time period, with total wage and salary employment earnings rising 43% and total proprietors' earnings rising 63% in 2020 dollars. Also in 2020 dollars, earnings per job grew 11% and per capita income grew 106% over the same time period. From 2000 to 2017, unemployment trends in the region outperformed the U.S. average.[929]

A partial listing of businesses in the Ely-Tower-Babbitt service area (including Eagles Nest, Morse, Stony River, and Fall Lake townships), Grand Marais and the Gunflint Trail, Lutsen/Tofte and the Sawbill Trail, Two Harbors, and Duluth,[930] is indicative of the strength of the region's amenity-based economy. All businesses in the region, not just those tightly identified with recreation and leisure, benefit from the spending of seasonal and year-round residents who would not live in the area but for the high quality of the natural amenities and the attractiveness of the BWCAW and wilderness edge areas. The list also includes a number of businesses elsewhere in the state for which the BWCAW represents the rationale for their products or a substantial destination for their customers.

Today, more than 72% of jobs in the Arrowhead region are "services related," a broad sector that includes health care, information, professional services, company management and support, and educational services, to name a few. Health care leads the services sector in growth in employment. From 2001 to 2019, the health care subsector added nearly 8,700 jobs in the three-county Arrowhead region, more than double the total number of jobs remaining in mining in

[926] Shirley, C.H., & Shirley, D. (2018, February 26). Letter to Cummins, C., Forest Supervisor, Superior National Forest. Sawbill Canoe Outfitters.
[927] Phillips, S., & Alkire, C. (2017).
[928] *A profile of socioeconomic trends - St. Louis County, Lake County, and Cook County, MN* (2021).
[929] Phillips, S., & Alkire, C. (2017).
[930] *Partial list of Minnesota businesses with focus on 3-County Arrowhead region* (2018). Compiled by Northeastern Minnesotans for Wilderness.

2020.[931,932] Professional services; educational services; and arts, entertainment, and recreation all grew between 17.6% and 26.6% between 2010 and 2019.[933] Measured from 2001 to 2019, all grew between 36% and 57%.[934]

III. Protecting the Withdrawal Area from sulfide-ore mining would allow continued growth and diversification of the economy, and avoid economic losses from harm to amenities, lost growth, and reversion to a mining-based economy

a. Continued stability, growth and diversification of the existing economy

In a 2017 report, Phillips & Alkire described the results of a non-random survey of business owners, including construction, manufacturing, retail, professional services, and recreation/tourism (lodging, restaurants, guiding/outfitting). On average, businesses anticipated substantial growth (40% on average) and investment over the next five to ten years in the absence of sulfide-ore mining. This is within the range seen in the Headwaters Economics Economic Profile System data for the Arrowhead region in recent years.

Protecting the region's greatest natural amenity – the BWCAW – will protect the conditions that have fed significant growth, diversification and investment in the Arrowhead region. Continued growth and diversification would mean more jobs, more wage and proprietor income, more economic activity, and improved conditions for entrepreneurial and cultural activity. It would also allow the continuation of the five-township Ely region (Ely plus Bald Eagle, Morse, Fall Lake, and Stony River townships)'s sustainable growth.[935] In the five-township Ely area the population rose by 1% from 2010 to 2019, with population growth in the surrounding townships overcoming a small decline within Ely.[936] In the context of the broad trend of steep population declines in Minnesota's rural areas, this small gain in population is a success story. The lift provided to Ely's and the regional economy by year-round and seasonal township residents and their home construction projects is significant.[937,938,939]

In addition, the proposed federal mineral Withdrawal would remove the current uncertainty over the future of the BWCAW watershed, which may be suppressing investment and property values, especially in the vicinity of and downstream from potential mine sites. The region and its communities could refocus attention on improving conditions in other ways, such as increasing the extent of high-speed broadband internet coverage and adjusting policies to address affordable

[931] *A profile of socioeconomic trends - St. Louis County, Lake County, and Cook County, MN* (2021).
[932] Harbin, D. (2021). (3,562 people were employed in Minnesota mines and mills as of the end of 2020.)
[933] *A profile of socioeconomic trends - St. Louis County, Lake County, and Cook County, MN* (2021).
[934] *Id.*
[935] Phillips, S., & Alkire, C. (2017).
[936] *A demographic profile of Eagles Nest, Fall Lake, and Stony River Townships, and Ely, with Minnesota* (2021). Created with Headwaters Economics' Economic Profile System, p. 4. Retrieved Nov. 28, 2021 from https://headwaterseconomics.org/apps/legacy-economic-profile-system/.
[937] Helmberger, M. (2017, August 3a). Ely's golden goose - Township residents power Ely-area economy. *The Timberjay*.
[938] Helmberger, M. (2017, August 3b). Township impact - In copper-nickel debate, we all should consider economic costs as well as gains. *The Timberjay*.
[939] Iron Range Resources and Rehabilitation Board (2011, May 6). *Northeastern Minnesota Jobs, businesses, economy boosted by impact of tourism industry*. Minnesota Dept. of Iron Range Resources and Rehabilitation.

housing shortages.[940] The proposed mineral Withdrawal would provide certainty to a wide range of businesses, property owners, and those looking to buy or sell businesses or real estate.

b. Avoidance of harm to the existing economy and its future growth

1. Allowance of sulfide-ore copper mining would cost the region and wilderness-edge communities jobs, income, property values, tax base, and more

The proposed Withdrawal in the Rainy River-Headwaters would avoid significant economic harm to the region, and costs to the state and/or federal government, which would be caused by sulfide-ore copper mining. Mining development would result in the loss of jobs and income in the region, along with cascading economic impacts, due to the failure or closure of recreational businesses and amenities in mining areas, as well as the ability of the region to hold existing and attract new residents. Longstanding businesses would be fatally harmed by the unavoidable effects of large mining operations. These include noise, light, air, and water pollution effects that extend beyond the mining facility footprint and into the surrounding area.[941,942]

A peer-reviewed analysis published in 2020 modeled the potential effects of a proposed mining development on jobs and income in the five-county Ely area over a 20-year time period. The analysis showed that in 89% of scenarios, within the first three to twelve years of operation the mine would cost the region more in both jobs and income than the region would gain.[943]

A second assessment of the potential types and magnitude of economic costs that would result from mining development is provided by Phillips and Alkire (2017).[944] These include:

- A decline in tourism/recreation spending as potential visitors choose alternative destinations with high quality scenic and recreational amenities undiminished by nearby mining activity. The study estimated an annual loss of $288 million in regional spending that would otherwise support 4,490 local jobs, $76 million in residents' income, $31 million in state and local taxes, and $181 million in proprietor's income and business-to-business transactions;

- In the rest of the Arrowhead economy, the study estimated 5,066 to 22,791 lost jobs, and between $402 million and $1.6 billion in lost annual income; and

- $509 million in lost property value. This is a one-time drop in asset value that would have recurrent consequences in local property tax revenue.

[940] *The Timberjay* (2021, August 11). Editorial. Worker shortage. http://timberjay.com/stories/worker-shortage,17987.
[941] Lee, J. (2019, January 10). Declaration. [Filing in *Voyageur Outward Bound School v. U.S.*, U.S. Dist. Ct. (D.C. Dist.) Case 1:18-cv-01463-TNM].
[942] Koschak, S. (2019, March 5). Declaration. [Filing in *Voyageur Outward Bound School v. U.S.*, U.S. Dist. Ct. (D.C. Dist.) Case 1:18-cv-01463-TN M].
[943] Stock, J.H. & Bradt, J.T. (2020). Analysis of proposed 20-year mineral leasing withdrawal in Superior National Forest. *Ecological Economics, 174*, 106663. https://doi.org/10.1016/j.ecolecon.2020.106663.
[944] Phillips, S., & Alkire, C. (2017).

These and other costs, including the economic consequences of the social harms associated with a return to boom-bust cycling in the Ely economy, the loss of property values as a consequence of mining and proximity to mining pollution,[945,946,947,948] and the costs to other sectors from instability in the labor market, would be avoided by the proposed federal mineral Withdrawal.[949]

The Withdrawal would also avoid the potential that public land owners would be required to pay a share of costs to address environmental damage if sulfide-ore copper mining were allowed. Mining or disposal of excavated or processed material on public lands could result in the Forest Service or the State being held a "potentially responsible party" under CERCLA, in which case the Forest Service or the State could be partially liable for the costs of remediation. That is precisely what happened to the U.S. Forest Service in *Chevron Mining, Inc. v. USA*,[950] where the estimated clean-up costs were approximately $1 billion.

c. The boom-and-bust dynamics of sulfide-ore copper mining would reduce economic activity, stability, and diversity in wilderness-edge communities

The proposed mineral Withdrawal would avoid harm to the region's economy resulting from the extension of boom/bust cycling into the greater Ely area. Boom times have the capacity to distort local economies in a number of ways not in keeping with long-term economic goals. For example, boom times may drive up wage competition beyond non-mining-related businesses' ability to pay. In addition, boom times may deplete local labor pools entirely, leaving businesses in other sectors of the diversified existing economy without candidates to hire or labor to operate. Workers in mining as well as in support industries (construction, road building, etc.) may forgo or postpone education, training, and other longer-term development opportunities and instead take work in the mining industry, only to be released with few additional skills or training in an economic downturn. As the taconite industry has shown, mining busts today are followed by ever-smaller booms in terms of mining employment.

These factors play out in unhealthy ways even in boom times, as this 2013 observation from the Mesabi Daily News attests:

> Even though mining, the region's biggest industry based on salaries, is running at near-full capacity, the employment and jobless numbers don't add up anywhere near as well for the Iron Range as the statewide averages…For the first seven months of 2013…a comparison of the statewide employment rate with that of the Iron Range shows the area's jobless rate is 64 percent higher than the overall Minnesota level.[951]

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945 Holmes, T.P., et al. (2015).
946 Keeler, B.L., et al. (2015).
947 Phillips, S. (2015).
948 Sun, B. (n.d.) *Econometric analysis of the effect of mining on local real estate values*. [PowerPoint].
949 Phillips, S., & Alkire, C. (2017).
950 *Chevron Mining Inc. v. USA*, 863 F.3d. 1261 (10th Cir. 2017).
951 Hanna, B. (2013, September 21). State jobs news quite good; but not so across the Range. *Mesabi Tribune*. https://www.mesabitribune.com/news/local/state-jobs-news-quite-good-but-not-so-across-the-range/article_211c6b80-b760-54fd-8b96-e8617fa42ae5.html.

Non-mining-related businesses (e.g., sporting goods stores) that struggle to find or hire employees in boom times may have to lay employees off and temporarily or permanently close when the mining industry has a sharp downturn, as customers cut back on spending. Research shows that communities heavily reliant on mining have more regular layoffs and relatively higher unemployment rates than adjacent, economically diversified communities. The whipsaw effects of labor shortages and wage pressure on one hand, and unpredictable cutbacks in customer base and consumer spending on the other, may discourage business investment, expansion and start-ups, and increase business closures. These forces may be self-reinforcing, as mining dependency decreases economic diversity and stability, and decreased economic diversity leaves communities increasingly dependent on mining.

When mining ends, as it did in Ely in 1967, a mining-dependent community's economy will not only have lost its mining jobs and tax receipts, but also will be less diversified and therefore less able to recover from mining's end. The damage done by mining to the community and its natural amenities also will leave it less able to attract newcomers, new business and residential/seasonal development, and diverse industries. Recovering from future mine closings would likely take longer and be less complete than the recovery since 1967, since sulfide-ore copper mining would damage the natural amenities on which Ely has based its current recovery.

In another vein, boom times can lead to a rapid increase in the demand for public infrastructure and services. These may have to be paid for by the city or township up-front, and the extended payback time can result in strained finances for many years. Some communities have built to meet increased demand and have suffered severe budget constraints or bankruptcy, either because the tax base did not expand sufficiently or because the boom turned into bust, leaving the community with infrastructure that could not be paid for or maintained.[952]

IV. The costs of banning sulfide-ore copper mining in the Rainy River-Headwaters have been mischaracterized by overstating mining benefits

Mining proponents tend to overstate the costs of protecting the BWCAW and its watershed in at least three ways: a) misuse of a deeply-flawed 2012 economic report; b) unreasonable reliance on mining company job projections for a project that is unlikely to be built for many years, at a time when the mining industry is rapidly replacing human mine workers with autonomous mining equipment; and c) unreasonable assumption that the jobs for a mine in the Ely area would be located in communities nearby. In addition, mining proponents erroneously assume that mining jobs will boost the regional economy in substantial ways that a similar number of diverse jobs in an amenity-based economy will not. Finally, mining proponents argue that the metals to be mined are needed for Minnesota's and the U.S.' electric vehicles (EVs), when it is highly unlikely that the concentrates produced here would stay in the U.S. (as further explained in Part 4, Section C below).

[952] Phillips, S. (2015).

a. A flawed 2012 economic report is misused to assert that sulfide-ore copper mining would have outlandishly large benefits for the region

A 2012 paper by Dr. James Skurla (hereinafter, "Skurla Report") [953] is often referenced by sulfide-ore copper mining proponents as a source for dramatic overstatements (by more than an order of magnitude) of the jobs and income that sulfide-ore copper mining would bring. The misinformation generated by this paper begins in the paper itself. As documented in a review by two other Ph.D. economists, the 2012 report reaches unreliable and inaccurate estimates of anticipated economic impacts based on an assumption that all mining projects then under consideration would be developed by the year 2016.[954] Additional errors in the study include:

- "…[Failure] to adhere to a number of the most critical EIA [economic impact analysis] methods. Multiple violations of standard EIA methodology undermine all generated [economic model] results."
- Inflation of the benefits of sulfide-ore mining;
- Omission of significant long- and short-term negative environmental, economic, and fiscal impacts of sulfide-ore mining in northeastern Minnesota;
- Understatement of the contributions from other sectors of Minnesota's economy;
- Over-statement of tax impacts from existing and proposed mining in Minnesota;
- Under-statement of tax breaks and tax kick-backs to the mining industry in Minnesota;
    - "[T]he mining industry is afforded minimal taxation by the State of Minnesota (an effective regional tax rate of less than one percent (<1%) of calculated direct output;"
    - "[A] substantial portion of the taxes collected are reinvested back into the mining industry;" and
- Gross overstatement of mining's share of Minnesota's GRP;
    - The study represented mining's share as 5.3% of GRP. In fact, it is 0.3%;
    - "This is a major discrepancy, and leads to a vast inflation of mining's importance."

The errors of the Skurla Report are exacerbated by the ways in which it is quoted and used. The report itself covers both ferrous and "nonferrous" (sulfide-ore copper) mining, and both existing and proposed operations. At one point in the report, the projected benefits of all existing and proposed, ferrous and nonferrous operations are summed. Opponents of watershed protection who quote the study have used this sum and similar numbers to represent the cost to the region if a subset of projects (i.e., sulfide-ore copper mining in the Rainy River watershed) are not allowed to go forward.

The results are absurd, and yet in this era of "alternative facts" have triggered critical government decisions. When President Trump announced his cancellation of the 2016 proposed federal mineral withdrawal, Rep. Paul Gosar described the Congressional Western Caucus's role in bringing that decision about, concluding, "When the President heard the numbers - 17,000

[953] Labovitz School of Business and Economics (2012). *The economic impact of ferrous and non-ferrous mining on the State of Minnesota and the Arrowhead Region, including Douglas County, WI.* University of Minnesota.
[954] Hjerpe, E., & Phillips, S. (2013). *A Review of 'The economic impact of ferrous and non-ferrous mining on the State of Minnesota and the Arrowhead Region.'*

jobs, $3 billion for education, $1.5 billion in annual wages, $2.5 billion annually for the economy - he recognized that the obviously right thing to do was to reverse the action."[955] The Congressional Western Caucus press release goes on to clarify that these were the numbers "at risk if the mineral withdrawal was allowed to stand."

The Skurla report, as inflated as its numbers are, estimates a maximum 1,790 total increase in jobs from nonferrous mining from all proposed projects in the entire Arrowhead region. This number includes "induced" jobs in industries ranging from food services to health care to retail sales – jobs that would also be induced by increased employment in other sectors. It is unclear where Rep. Gosar got his numbers, but what is clear is that mining proponents vastly overstate the jobs and financial benefits that would accrue from nonferrous mining in the Rainy River-Headwaters in their efforts to defeat proposals for increased protection.

Furthermore, over the past ten years the Skurla Report's predictions have proven wrong. The report predicted 5,029 new jobs in taconite mining and 427 new jobs in copper mining by 2016; increased revenue and other financial benefits were in turn based on these numbers. But in fact, the taconite industry shed jobs over the projected period. No new mining jobs have been created, although some workers who were laid off during the industry slump were eventually called back.

In sum, those opposing the Withdrawal have in the past misquoted a flawed economic report to arrive at fanciful job and income predictions for sulfide-ore copper mining in the Rainy River-Headwaters. While it is reasonable to assume that the proposed rule amendment would eliminate potential jobs in the nonferrous metallic (sulfide-ore copper) mining industry, it is wrong to suggest that the proposed Withdrawal would negatively affect the existing taconite industry's benefits to the region. In addition, numbers from the Skurla report are often used with the assumption that no alternative economic development or growth would occur in the absence of mining, an assumption that ignores the realities of the current amenities-based economy.

b. The mine automation advancements made in recent years mean that mines require fewer employees

Claims regarding the number of people mines would employ must be seen in light of an accelerating trend of declining labor intensity in the mining industry. It is likely that the number of people employed at a sulfide-ore copper mine in the Rainy River-Headwaters would peak at or shortly after the commencement of production, as optimization and increasing automation are likely to increase the rate of production with fewer employees over time. At some point in the future, fully autonomous operation will be the benchmark for mines.[956] Between now and that day, an increasing degree of automation will allow progressively fewer workers to monitor more pieces of autonomous equipment, and each year fewer people on average will be required to operate a mine at the same or higher output volumes. Furthermore, the control rooms for autonomous equipment can be located tens or hundreds of miles from a mine.

[955] Congressional Western Caucus (2018, June 21). Trump: 'I will be cancelling the Superior National Forest mineral withdrawal.' Caucus: 'You're the best.' [Press release]. https://westerncaucus.house.gov/news/documentsingle.aspx?DocumentID=1568.
[956] MacLean Engineering. (2017, Oct. 1). The robots Are coming. *Mining Magazine*. https://www.miningmagazine.com/partners/partner-content/1331728/the-robots-are-coming.

Mining companies are "rolling out autonomous trucks, drills, and trains, which will boost efficiency but also reduce the need for human employees."[957,958] Rio Tinto, BHP Billiton, and Suncor are using autonomous driverless haul trucks. Rio Tinto sees automation (e.g., its fleet of more than 70 driverless mining trucks at one of its mines) and remote monitoring of automated equipment as a way to increase efficiency and reduce mining staff.[959] Copper mining giant Anglo American predicted in 2017 that most of its underground mines will be fully automated within a decade.[960]

Antofagasta is now in the process of testing automation at its Centinela mine in Chile. An advanced "Integrated Operations Center" has been built for digitization and "remotisation" of the mine's operations. The operations center is said to be located in the regional capitol, which is roughly 90 miles as the crow flies from the Centinela mine.[961,962]

One of the essential first steps in automating a mine is the electrification of the mining vehicle fleet.[963] TMM has already announced that its underground fleet of mining equipment would be electric- rather than diesel-powered,[964] but has not discussed automation of the electric underground mining equipment.

The continuing trend of automation and now roboticization of many functions in modern mines means that estimates made now (or years ago) of the number of jobs at a future mine are certain to be inflated. The number of jobs Twin Metals estimates its mine would provide includes many positions that would be lost in the intervening years as a result of improvements in turn-key mining automation packages that will become available in the coming years. Additional jobs in proposed mines of the future would involve monitoring (rather than operating) multiple pieces of autonomous vehicles and equipment, which could be done by Metro-area or overseas workers located hundreds of miles away from the mine.

That is the case with Rio Tinto's employees who, from a control center in a major metropolitan area, each monitor multiple driverless haul trucks operating 24 hours a day at the West Angelas

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957 Simonite, T. (2016, December 28). Mining 24 hours a day with robots. *MIT Technology Review*. https://www.technologyreview.com/2016/12/28/154859/mining-24-hours-a-day-with-robots/.

958 MacLean Engineering. (2017, Oct. 1).

959 Simonite, T. (2016, December 28).

960 Bloomberg News. (2017, November 29). Robots will run mines within the next decade, Anglo says. *Mining.com.* ("[our] 'employee of the future' will only need to focus on managing the company's relations with governments and communities that live near its mines….") https://www.mining.com/web/robots-will-run-mines-within-next-decade-anglo-says/.

961 Moore, P. (2021, May 6). Antofagasta Minerals' Minera Centinela advances Integrated Operations Centre with full operation set for end of 2022. *International Mining*. https://im-mining.com/2021/05/06/antofagasta-minerals-minera-centinela-advances-integrated-ops-centre-full-operation-set-end-2022/.

962 Moore, P. (2021, Nov. 17). Antofagasta progressing with Autonomous Systems Implementation Project at Minera Centinela. *International Mining.* https://im-mining.com/2021/11/17/antofagasta-progressing-autonomous-systems-implementation-project-minera-centinela/.

963 Williams, D. (2021, July 15). Two of the biggest topics facing miners are electrification and automation. *MiningMonthly*. https://www.miningmonthly.com/partners/partner-content/1413731/two-of-the-biggest-topics-facing-miners-are-electrification-and-automation.

964 Twin Metals Minnesota (2021, August 12). Twin Metals Minnesota commits to electric vehicle fleet. [Press Release]. https://www.twin-metals.com/press-release/twin-metals-minnesota-commits-to-electric-vehicle-fleet/.

mine, 750 miles away.[965] In fact, a single control center can provide monitoring and control for multiple mines, further reducing the number of employees per mine.[966]

Furthermore, many of the higher paying jobs available to blue-collar workers in mines operating today are the ones most likely to be lost, as employment skews increasingly toward professional, technical (e.g. engineering and I.T.), and managerial positions in major population centers. The lesser-skilled positions are being replaced by automated equipment, and the best-paid positions are some of those most likely to shift away from the community hosting a mine. As a result, the "shared-value paradigm" of a mine not only making profits for the company but also delivering significant economic benefits to the host community is becoming a thing of the past.

In summary, not only would an initial Twin Metals mine involve far fewer jobs than currently claimed, but many of those jobs would likely go to people hundreds or even thousands of miles away who have no other connection to the area, rather than to local workers. Economic projections based on past mining practices will not prove accurate.

PART 3: SCOPE OF REVIEW AND ALTERNATIVES

A. The environmental review should address the overarching question of whether this watershed is simply the wrong place for sulfide-ore copper mining

The environmental review now underway on the proposed Withdrawal is appropriate and the only means of addressing the threshold question of whether the Rainy River-Headwaters watershed is the wrong place to consider sulfide-ore copper mining. The BWCAW and its watershed areas outside the Wilderness are ecologically unique, culturally significant, and would be especially vulnerable to contamination from sulfide-ore copper mining. The process now being followed is also consistent with the American Fisheries Association recommendations in its 12-29-2015 position paper.[967]

By the time a project gets to the project-specific environmental review stage, the threshold question (whether the location is appropriate for considering that type of mining project) effectively has been bypassed, or answered in the default and without analysis. This is one of the reasons why project-by-project review is inadequate. Whether an area as unique, intact, and vulnerable as the Rainy River-Headwaters is appropriate for consideration of a new and regionally untested industrial activity like sulfide-ore copper mining is most appropriately addressed in a withdrawal proposal review like the one underway.

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[965] Simonite, T. (2016, December 28).

[966] ABB (2015). *Next level mining: Securing the future through integrated operations & information technologies.* [White paper].

[967] Hughes, R.M, et al. (2016). American Fisheries Society Position Paper and Policy on Mining and Fossil Fuel Extraction, *Fisheries*, 41(1) 12-15. DOI: 10.1080/03632415.2016.1121742.

I. This is an ecologically unique and culturally significant area that is beloved and used for activities that are inherently incompatible with industrial mining

As discussed in Part 2., Section A.I., the Withdrawal Area and the BWCAW downstream form the heart of a unique ecosystem, and part of an internationally-significant lakeland canoe country. The landscape is defined by its complex network of lakes and rivers, which are of exceptionally high quality and also – due to the interconnectedness and low buffering capacity of the waters and soils – extremely vulnerable to mining pollution. The BWCAW is the most-visited wilderness area in the National Wilderness Preservation System, and the largest wilderness area east of the Rockies and north of the Everglades. The Superior National Forest, including the Withdrawal Area, the MPA and the BWCAW, support a diversified, stable, growing amenity-based economy that has helped to insulate much of the area and Wilderness gateway communities from the economic and social harms of the boom-and-bust cycling common in mining towns. The Withdrawal Area coincides with the unprotected headwaters of the BWCAW and other protected areas, and is heavily used and recreationally, socially, culturally, and economically important to the region.

II. The only effective method of environmental review is to address the question of whether any sulfide-ore mining should occur here before review is undertaken for specific projects

As stated in the U.S. Forest Service's 2021 Application for Withdrawal, "[e]xercise of consent authority entails a piecemeal, project-specific approach that may result in similar protection but only at a more localized scale."[968] A broader, more comprehensive approach is appropriate now, because what is known about the inherent risks of sulfide-ore copper mining and the common failings of the project-specific approach are applicable to the entire watershed and all foreseeable mine projects that would be proposed in the watershed.

As discussed above in Part 2, Section A.II.j., project-specific environmental review and permitting processes generally fail to predict and prevent the water pollution and standards violations that occur after hardrock mines begin operating. The permitting process relies on implementation of mitigation measures, and yet pollution occurs despite mitigation measures being in place. In short, any process that leaves the Rainy River-Headwaters' door open to mining projects leaves the watershed open to mining-caused contamination and degradation.

Moreover, any project-specific review process would fail to account for the encouragement of expansions and additional projects that would ensue if the first sulfide-ore copper mine were allowed in the watershed. Absent protection, the Withdrawal Area could be converted over time into a sprawling sulfide-ore copper mining district. The potential cumulative impacts of several mines needs to be considered before any one mining project is considered.

The review now under way is necessary and appropriate. The Withdrawal environmental review considers first the threshold question: Is this ecologically unique, sensitive, vulnerable watershed, with all of its social, cultural, and economic importance on the line, an appropriate

[968] U.S. Forest Service (2021, Sept.). *Application for Withdrawal, Superior National Forest, Cook, Lake, and Saint Louis Counties*. U.S. Dept. of Agriculture, at p. 10.

place to consider opening up for conversion by the most-polluting industry in America? The Withdrawal review also offers an opportunity to assess the alternative scenario – through the no action alternative – of a sulfide-ore copper mining district being established in the Rainy River-Headwaters on the doorstep of the BWCAW. Consideration of the best available science fully supports the proposed action to withdraw the Rainy River-Headwaters from federal mineral leasing in order to protect the Withdrawal Area, the MPA, and the BWCAW and other downstream/downwind protected areas.

B. The Forest Service should consider realistic mining scenarios

As part of a robust analysis of a no action/no withdrawal alternative, the Forest Service should consider possible future mining scenarios, including the possibility that several deposits might eventually be mined in the Withdrawal Area.

I. The potential exists for multiple mines to be developed if the Withdrawal does not occur

If the Withdrawal were to be denied, it is foreseeable that additional mineral leases, exploration, and sulfide-ore copper mines could eventually be allowed in the watershed. If a first sulfide-ore mine is allowed in the watershed, there is a reasonable potential for additional mines to be developed at some point in the future. The U.S. Forest Service should consider the negative effects of the proposed Twin Metals Maturi project, but should also assess the potential for cumulative degradation associated with multiple mines that might follow under a no-withdrawal scenario. Such a mining district could encompass several mines within a twenty-mile area, stretching from the divide at the top of the watershed to the very edge of the BWCAW. The Forest Service should consider what mining at such a scale would mean for the BWCAW, the MPA, the Withdrawal Area, and the surrounding forest, landscape, waters, existing uses, and wildlife. Realistic development of the Duluth Complex beyond the Laurentian divide, such as the NorthMet project, should also be considered to the extent that cumulative effects (e.g., air emissions) would bridge the watershed divide.

a. The review should consider the potential for mining at other identified deposits with active exploration/planning

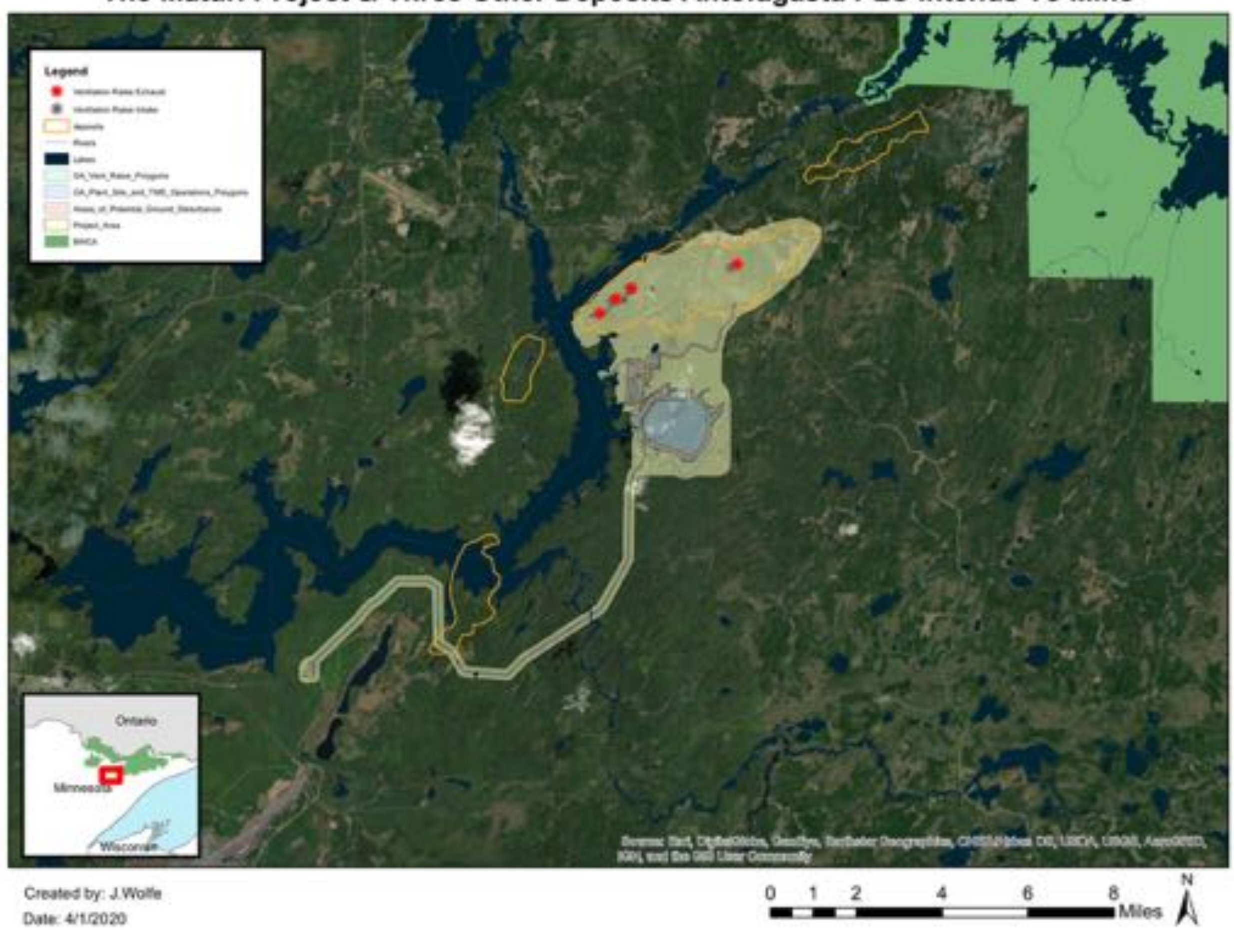
The Forest Service's assessment of the potential consequences of a withdrawal denial should consider the potential for future mining of other deposits in the Withdrawal Area. If a threshold is helpful in determining which deposits might have "potential," the Forest Service could use the existence of an NI 43-101 (Prefeasibility Study) as that threshold. Four deposits in the Withdrawal Area, all claimed by Antofagasta-Twin Metals, are covered by a prefeasibility study.

Antofagasta-Twin Metals has made no secret of its intention to develop four deposits to which it claims lease interests in the Birch Lake area. That intention is clearly laid out in its last public technical report, which was filed with the Canadian Securities Administrators in 2014.[969] The

[969] Duluth Metals (2014, Oct.). *Twin Metals Minnesota Project, Ely, Minnesota, USA, NI 43-101 Technical report on prefeasibility study*. *See also,* Antofagasta PLC (2019). *Annual Report and Financial Statements 2019,* pp. 66,

company also lists all four deposits – Maturi, Spruce Road, Maturi SW, and Birch Lake – in its mineral resource estimates found in its annual reports for shareholders, an indication that shareholders can expect that the company would seek to develop all four deposits, eventually.[970] Its initial plan was to begin development with the Maturi and the Maturi Southwest deposits combined, with a throughput of 50,000 st/d. Considering depth and geology, full development of Maturi SW, if it occurred, would likely include open pit mining.[971] The four deposits are shown, outlined in yellow, in the figure below.

The Maturi Project & Three Other Deposits Antofagasta PLC Intends To Mine



The current plan for the Maturi deposit alone is to mine 163 million metric tonnes over a 25-year mine life.[972] This represents just 10% of the 1.643 billion metric tonnes of total mineral resources that Antofagasta represents as contained in the Maturi deposits, and just 7% of the 2.509 billion metric tonnes that it shows as its total mineral resources and ore reserves.[973] These numbers

114, 115 (Asserting that Antofagasta has completed a 2018 update to the October 2014 prefeasibility study. That update has not been made public).

970 *See,* e.g., Antofagasta PLC (2020). *Annual Report and Financial Statements 2020*, p. 228

971 Duluth Metals (2014, Oct.). (*See* p. 14-30: "Although the resource classification is based on an underground mining scenario, the deposit will likely be mined to the surface at some point in the future."

972 Twin Metals Minnesota (2019a), lines 217-218.

973 Antofagasta PLC (2020), at p. 228.

suggest that Antofagasta-Twin Metals ultimately plans to mine at a much larger scale than indicated by its initial mine plan. It also raises questions about the reclamation and mine lifespan components of the company's 2019 mine plan of operations.

b. Review should consider how development has progressed in similar districts

It is common for an initial mine project to be followed by proposed amendments to expand the size, the rate of mining, the duration of mining, or some combination or the three. Environmental review should consider what mining the known deposits at various scales would mean for the BWCAW and the surrounding forest, landscape, waters, and wildlife, including a scenario based on the largest realistic amount of mining in the watershed. The environmental review should also consider realistic development of the Duluth Complex beyond the Withdrawal Area to the extent that cumulative effects (such as air impacts from projects just outside the Rainy River-Headwaters) could be expected inside the Withdrawal Area. History shows that commonly, mining eventually extends far beyond the scope envisioned when mining first begins.[974] While there is no guarantee that any proposed mine or mining of a new deposit would occur, particularly in economically marginal deposits, there is a potential that ultimately multiple mines or the mining of multiple deposits would have effects on the BWCAW and Withdrawal Area resources in the absence of the proposed Withdrawal.

c. Assessment of cumulative impacts should be based on realistic assumptions regarding mine features as allowed by Minnesota law

Twin Metals has submitted an initial plan based on an underground mine and a drystack tailings facility; this should not be assumed to be representative of the mine plans that will follow. Rather, the assessment should consider likely scenarios based on the depth of deposits, volume of tailings, space availability, economics, and other relevant factors. To assess the types of projects Minnesota state agencies would likely approve, the PolyMet NorthMet project is illustrative. The Minnesota Department of Natural Resources (MDNR) takes the position that if a proposed mining project meets the regulatory requirements, it has no authority to deny permits. The agency clearly believes that all aspects of the NorthMet project meet regulatory requirements. The Forest Service should thus assume that mines similar to the NorthMet project – i.e., open pit, with permanent surface waste rock stockpiles and a standard tailings basin – could also be permitted in the Rainy Rivers Headwaters Watershed.

Because the industry has not yet devised a way to mine without contaminating groundwater if groundwater is intercepted, the creation of multiple hazardous waste sites in the headwaters of the BWCAW would be an inevitable result of permitting mines. The Forest Service can look to the NorthMet project to see what level of groundwater contamination state regulatory agencies are willing to permit; for copper, that level is more than 1,000 times the surface water quality standard.[975] These levels are similar (and in some cases higher than) the metals found at

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[974] A minor example is the Eagle Mine in Michigan, which began operations in 2014 with an eight-year life of mine and has recently confirmed a new ore body, Eagle East, which will extend the life of the mine by two years. Eagle Mine (2019, Sept. 30) *Eagle East*. Retrieved Jan. 15, 2022, from http://eaglemine.com/eagleeast/

[975] See Part 2, Sect. A.II.2. above.

Superfund and other contaminated sites that are currently being cleaned up in Minnesota.[976] The Forest Service should consider the risks involved with this degree of groundwater contamination at several mine sites spread throughout the Rainy River Headwaters upstream of the BWCAW.

Another issue with widespread impact across the landscape is the cumulative impact of air emissions, including deposition of air pollutants into wetlands and other waters. Minnesota researchers recognized in 1977 that mining might not be appropriate in the Withdrawal Area due to the impacts of air pollution in the BWCAW.[977] Environmental review should consider a realistic scenario of fugitive dust and others emissions from several mines, and the potential cumulative impact on the BWCAW and other high-quality waters.

II. The proposed Maturi mine alone would have significant impacts that the Forest Service should consider in environmental review

The Maturi project proposed by Antofagasta-Twin Metals Minnesota would alone have significant impacts on the Birch Lake–South Kawishiwi River area, the MPA, and the BWCAW. The effects this project would have if developed are obviously relevant to environmental review for the proposed Withdrawal. While a full assessment is not possible with the data currently available, and would be inappropriate for this level of environmental review, the Mine Plan of Operations submitted by Twin Metals represents a likely mining scenario if the watershed remains open to leasing and mining. Likely effects of this scenario should be considered at a programmatic level in the No-Action Alternative for the Withdrawal environmental review. The effects summarized below are limited to those that would occur without significant accidents or miscalculations. They do not include the many risks of more catastrophic consequences if something goes significantly wrong.

Like other mines, the proposed Maturi project would create and leave very large areas of polluted groundwater within and around backfilled mine workings and beneath and around the tailings disposal facility.[978] The contamination would likely follow preferential pathways to reach surface waters.[979] Accidents, spills, storms, and mitigation measures that are less effective than expected would at some point result in unexpected discharges, as they do at all mines.[980] Large-scale land clearing, stockpiling peat and soils, and using this material for construction would result in significant degradation of downstream waters, including increases in mercury, sulfate, total dissolved solids, and other pollutants.[981] Contaminant loadings to Keeley Creek and Birch Lake would increase.[982] Contamination from underground workings, leachate, and spills

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[976] MPCA (n.d.k). *Minnesota Groundwater Contamination Atlas*. Retrieved December 28, 2021 from: https://www.pca.state.mn.us/data/minnesota-groundwater-contamination-atlas. Sites with metals contamination include Perham arsenic site, the old Duluth landfill, the Burnsville freeway landfill, the Carlton County 2 landfill, and the Pickett landfill. The MPCA website provides Xcel spreadsheets with monitoring data for each of these sites.
[977] Ashbrook, P. (1979). *Impacts of fugitive dust emissions from a model copper-nickel mine and mill.* [Draft report]. Minn. Dept. of Environmental Quality.
[978] See Part 2, Section A.II.a.2.
[979] See Part 2, Section A.II.e.
[980] See Part 2, Section A.II.j. and k.
[981] *See* Parts 2, Section A.II.g.
[982] See Part 2, Section A.II.l.

that migrates to surface waters would flow into the BWCAW.[983] The increase of sulfates and mercury to local wetlands and other surface waters would increase methymercury production, increasing mercury levels in fish tissue. [984]

A drystack tailings facility has been proposed for the Maturi project.[985] This facility would present long-term risks of the leaching and mobilization of heavy metals and of movement due to instability and/or slumping.[986] Runoff and leachate would be collected in unlined ditches that would leak to groundwater.

After the mine was closed and the tailings pile covered, the cover would need to maintain its integrity for millennia. The cover would extend over a 130-foot hill covering a nearly one-square-mile area. The effectiveness of the cover would be uncertain even in the short term, but Twin Metals hopes to walk away from this site completely after post-closure monitoring year 25.[987] When the cover deteriorates after many decades or a century has passed, increased infiltration of precipitation will ultimately result in increases of sulfate and other constituents in Birch Lake and other downstream waters.

The drystack facility would create significant fugitive dust, as would haul roads and other sources. This dust would be added to mobile and controlled emissions that together would affect air, visibility, and water for significant distances, including local recreation areas and the BWCAW.[988] These emissions would contain sulfur, heavy metals, and other pollutants. Much of the time, this pollution would be blown to the northeast, north, and east into the BWCAW and other protected areas. Regardless of wind direction, air emissions and fugitive dust would be deposited or washed into the wetlands, lakes, and streams that cover the site and flow into the BWCAW. Air emissions would also be deposited onto U.S. Forest Service campgrounds and backcountry dispersed campsites and private property including homes, cabins, and resorts.

The Maturi mine plan includes features that would be extremely problematic if miscalculations are made (and miscalculations of one kind or another are made at virutally every mine) regarding hydrogeology,[989] storm events,[990] geochemistry,[991] or the effectiveness of mitigation measures.[992] Among others, these features include the lack of a water treatment plant and the assumption that all process water will be able to be perpetually recycled without treatment or discharge. The Maturi mine as planned would likely to be economically marginal, resulting in potential financial difficulties if things do not go as planned.[993]

[983] Myers, T. (2016a). Acid Mine Drainage Risks - A Modeling Approach to Siting Mine Facilities in Northern Minnesota USA. *Journal of Hydrology*, 533, 277–90.
[984] See Part 2., Section C.II.e.
[985] Twin Metals Minnesota (2019b).
[986] See Part 2., Section A.II.j.
[987] Twin Metals Minnesota (2021, March 12). *Scoping Environmental Assessment Worksheet Data Submittal Update*. *See* p. 10, third bullet point.
[988] See Part 2, Section B and Section E.
[989] See Part 2, Section A.II.e.
[990] See Part 2, Section A.II.k.
[991] *Id.*
[992] See Part 2, Section A.II.j.
[993] See Part 2, Section A.II.h.

The proposed Maturi mine project would also degrade and destroy terrestrial[994] and aquatic[995] habitat and create noise and light pollution.[996] Wildlife species, including the federally-listed Canada lynx and northern long-eared bat, would be impacted.[997] Rare and highly biodiverse native plant communities would be destroyed or degraded.[998] The mine would destroy the natural, near-wilderness character of the Birch Lake-South Kawsihiwi River area and would significantly affect wilderness character in the BWCAW.[999]

PART 4: POLICY CONSIDERATIONS

A. Withdrawal is entirely consistent with and necessary to advance this Administration's 30x30 commitments and to combat the climate and biodiversity crises

Executive Order 14008 directs the federal government to conserve 30 percent of all land and water within the United States by 2030, creates a task force to assemble a government-wide action plan for reducing greenhouse gas emissions, and elevates climate change to a national security priority.[1000,1001] A key part of fulfilling the 'whole-of-government' approach to the climate crisis includes specific actions by federal land management agencies to determine which public lands should be protected from mining and other extraction, an action the DOI and USDA have taken in initiating the Proposed Action.[1002] Protecting and preserving Minnesota's Boundary Waters Wilderness and its surrounding boreal forests from sulfide-ore copper mining is an important part of the climate solution, including carbon sequestration and climate adaptability and resilience.

The Proposed Withdrawal is necessary and fully in line with the Administration's priorities in addressing the climate and extinction crises and would deliver multiple benefits including preserving carbon sequestration; avoiding the massive energy demand of large sulfide-ore copper mines and thus eliminating major new greenhouse gas sources; and ultimately protecting a broader 4.3-million-acre ecosystem that provides a refuge for species threatened by climate change.

The Withdrawal Area is vital for carbon sequestration. The 4.3 million-acre Quetico-Superior region is primarily boreal forest. Boreal forests, because of the carbon in peat, store more carbon than any other terrestrial ecosystem — almost twice as much per acre as tropical forests.[1003]

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[994] See Part 2, Section D.
[995] See Part 2, Section C.
[996] See Part 2, Section E.
[997] See Part 2, Section C.
[998] See Part 2, Section D.
[999] See Part 2, Section E.
[1000] Executive Order 14008, Tackling the Climate Crises at Home and Abroad, 86 Fed. Reg. 7619 (Jan. 27, 2021).
[1001] U.S. Department of Agriculture (2021, May 6). Biden-Harris Administration outlines "America the Beautiful" initiative. [Press Release]. Retrieved December 30, 2021 from https://www.usda.gov/media/press-releases/2021/05/06/biden-harris-administration-outlines-america-beautiful-initiative
[1002] America the Beautiful Interagency Working Group (2021). *Year One Report America the Beautiful*. p. 19
[1003] Carlson, M.C., Wells, J., & Roberts, D. (2009) *The carbon the world forgot: conserving the capacity of Canada's boreal forest region to mitigate and adapt to climate change.* Boreal Songbird Initiative and Canadian Boreal Initiative, Seattle, WA, and Ottawa. 33 pp.

Keeping carbon locked in these forests and out of the atmosphere is a vital part of the fight to keep warming below 2 degrees Celsius. According to a federal government report prepared for members and committees of Congress, each acre of terrestrial boreal forest stores on average 182 tons of carbon in its vegetation and soils.[1004] Destruction of boreal forest for industrial mining would both release much of that carbon into the atmosphere while simultaneously decreasing the capacity of the land to take up carbon in the future. The loss is even greater if wetlands are destroyed as soil carbon levels in wetlands are nearly double the level in the terrestrial boreal forest.[1005]

Mechanical destruction of vegetation and soil is not the only harm that would result from permitting copper mining; the carbon storage assets of the Boundary Waters region (surface vegetation, soils, wetlands, and peatlands) are incredibly vulnerable to acid mine drainage, as discussed in Part 2, Section A.II.b. above.

Protecting the Withdrawal Area is also critical for greenhouse gas emission avoidance. An estimate of greenhouse gas emissions, based on a 2014 Prefeasibility Report for the proposed Twin Metals mine, is 23,444,730 metric tons of CO_2 over a 20-year life of the mine.[1006] This is equal to greenhouse gas emissions from adding nearly 5 million passenger vehicles to the roads for one year.[1007]

Protecting the Withdrawal Area and the BWCAW through the Proposed Withdrawal is crucial for climate adaptation and resilience. The Wilderness Society identified 74 places in the United States that are crucial to our ability to sustain biodiversity in the face of a changing climate.[1008] These areas have three essential characteristics: (1) an especially high degree of wildness; (2) connectivity to existing protected areas; and (3) diversity of unprotected species and ecosystem types. The analysis found that the Quetico-Superior region is one of the top places in the nation with this "Wildland Conservation Value."[1009,1010]

A 2018 study by The Nature Conservancy with similar findings underscores the necessity of keeping these areas intact and undeveloped.[1011] Consistent with this, The Nature Conservancy, The Conservation Fund, and The Trust for Public Land have acquired large swaths of land across northern Minnesota to keep them protected. Allowing the creation of an industrial mining zone

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[1004] Gorte, R.W. (2009). *Carbon Sequestration in Forests*. Congressional Research Service Report for Congress, p. 5 Table 1 shows average carbon stocks for various biomes in tons per acre.
[1005] *Id.* p.5, Table 1 shows average wetland soil carbon storage at 287 tons of carbon per acre.
[1006] Duluth Metals (2014, Oct.), p. 18-26.
[1007] Campaign to Save the Boundary Waters (n.d.b). *Estimated Climate Impacts of Proposed Twin Metals Minnesota Mine.* [Fact Sheet]. Northeastern Minnesotans for Wilderness.
[1008] Belote, R.T., Aplet, G.H., Carlson, A.A., Dietz, M.S., May, A., McKinley, P.S., Schnure, M., & Garncarz, J. (2021). Beyond priority pixels: Delineating and evaluating landscapes for conservation in the contiguous United States. *Landscape and Urban Planning 209 (2021) 104059*. https://doi.org/10.1016/j.landurbplan.2021.104059.
[1009] *Id*. *See* Table 1 on p. 7.
[1010] Belote, R.T., Dietz, M.S., Jenkins, C.N., McKinley, P.S., Irwin, G.H., Fullman, T.J., Leppi, J.C., & Aplet, G.H. (2017). Wild, connected, and diverse: building a more resilient system of protected areas. *Ecological Applications* 27(4), pp. 1050-1056.
[1011] Anderson, M.G., Clark, M.M, Cornett, M.W., Hall, K.R., Olivero Sheldon, A. & Prince, J. (2018). *Resilient Sites for Terrestrial Conservation in the Great Lakes and Tallgrass Prairie.* The Nature Conservancy, Eastern Conservation Science and North America Region.

in the watershed of the Boundary Waters by denying the Proposed Action would undermine the work that these and other organizations are doing to prepare us for the future.

B. There is no social license for sulfide-ore copper mining in the Boundary Waters watershed

I. History of protection

Protecting the lands and waters within what are now the BWCAW and the rest of the SNF is a project that has been underway for more than a century. Protections have increased as new threats have arisen, more scientific knowledge has been gained about the vulnerability of water and land, and more people have recognized that these are priceless public lands that bestow enormous benefits on the nation. The legislative and administrative history of protection of the BWCAW area makes clear that the protection of the unique resources of the area has always been a priority, and that the steps required to protect the Quetico-Superior region have changed over time to meet the exploitative pressures of the day.[1012]

For more than 115 years, the United States and the State of Minnesota have worked together to protect the U.S. lands and waters of the Quetico-Superior region, particularly those areas that encompass the SNF including the BWCAW and VNP. Protective actions by the U.S. and Minnesota have been matched by reciprocal protections from Ontario on the Canadian side of the border, resulting in a border-spanning protected lakeland wilderness landscape unlike any other in size and quality.

On several occasions U.S. protections have come in the form of withdrawals of federal land from homesteading, logging, mining, and motorized use. After the first withdrawal of 500,000 acres from the U.S. General Land Office (GLO) in 1902, Minnesota's first Forestry Commissioner, Civil War veteran General Christopher C. Andrews, successfully petitioned the GLO to withdraw an additional 659,700 acres in order to protect some of the Quetico-Superior area from unsustainable and chaotic private harvesting of timber. The GLO's three land withdrawals totaled more than 1.1 million acres of U.S. public domain forest lands, lakes, and islands, all in what Andrews considered to be one of the most important and beautiful localities in Minnesota.[1013]

These initial federal land withdrawals provided the foundation for President Theodore Roosevelt's establishment of the SNF in February 1909. Ontario's provincial government, which was dealing with similarly unsustainable practices, followed suit by establishing a forest reserve that four years later became Quetico Provincial Park. Canada and the United States also created the International Joint Commission (IJC) in 1909 in recognition that each country's lakes and rivers are affected by the other's actions along the border. A key provision of the 1909 Boundary Waters Treaty is "that neither the U.S. nor Canada will pollute boundary waters, or waters that

[1012] In 1978, a moratorium was in place to study sulfide-ore Cu-Ni mining, and the full extent of the massive threat to the BWCAW posed by a new type of mining was not yet known. Had it been clear in 1978, the MPA may have been extended to cover the entire BWCAW watershed.
[1013] Searle, R. N. (1977). *Saving Quetico-Superior: A Land Set Apart*. Minnesota Historical Society Press. 289pp. [Not included in Appendix].

flow across the boundary, to an extent that would cause injury to health or property in the other country."[1014]

A decade after establishment of the Superior National Forest, in response to the influx of people seeking recreation, the U.S. Forest Service prepared a recreation plan that favored primitive recreation over roads. In 1926, after a multi-year controversy over a campaign to build "a road to every lake" in the Forest, Secretary of Agriculture William Jardine directed that 640,000 acres be managed as the Superior Wilderness, which ultimately became the Boundary Waters Canoe Area Wilderness.

The list of subsequent governmental actions to protect the BWCAW from harmful development, including in many instances from mining, is extensive. Some of the highlights in the history of past protective actions include:

1930 Congress passes the Shipstead-Newton-Nolan Act[1015] relating specifically to the Superior National Forest, conserving the beauty of shorelines on waters navigable by boats or canoes; prohibiting logging within 400 feet of shorelines; barring alteration of natural water levels by dams; and withdrawing all protected federal lands from homesteading.

1933 In response to excessive shoreline logging on state lands, Minnesota passes legislation providing Shipstead-Newton-Nolan Act protections for state lands.[1016]

1934 The IJC blocks a proposal by lumber baron Edward W. Backus to build a series of dams along the international border to raise water levels to facilitate logging operations.

1946 Congress passes legislation that precludes mineral development on lands acquired pursuant to the Weeks Act (which includes most of the Superior National Forest) unless the Secretary of Agriculture determines that the development "will not interfere with the primary purposes for which the land was acquired."[1017]

1948 Congress passes the Thye-Blatnik Act[1018] to allow the U.S. Forest Service to buy resorts, cabins, and private lands in the Superior Roadless Area. (Acquisitions continued through the 1970s.) The U.S. Forest Service issues a new management plan, establishing a "no-cut" area and limiting motorboats to already established areas.

1949 In response to seaplanes and other overflights affecting the primitive character of the Superior Roadless Area, President Truman issues an executive order establishing an unprecedented airspace reservation for conservation purposes, prohibiting flights below 4,000 feet mean sea level.[1019]

1014 Boundary Waters Treaty of 1909, Art. IV, Jan. 11, 1909, 36 Stat. 2448.
1015 16 U.S.C. § 577 et seq., 46 Stat. 1020, ch. 881 (July 10, 1930).
1016 Minn. Stat. § 103G.545, subd. 1.
1017 Reorganization Plan No. 3 of 1946, § 402, 60 Stat. 1097, 1099 (July 16, 1946).
1018 Pub. L. No. 733, 62 Stat. 568 (July 22, 1948).
1019 Exec. Order No. 10092 (Dec. 17, 1949), 36 C.F.R. § 294.2.

1964 Congress passes the Wilderness Act, establishing the National Wilderness Preservation System.[1020] The Boundary Waters Canoe Area is included in the first nine million acres designated to remain "untrammeled by man," although continued logging and motorboat use is not prohibited.

1965 U.S. Secretary of Agriculture Orville Freeman issues 13 directives dealing with BWCA, adding to the no-cut zone, zoning for motorboats, and more.

1976 The Minnesota legislature designates state lands within the BWCAW as wilderness, and prohibits all mining on state lands within the BWCA.[1021]

1978 Congress passes the Boundary Waters Canoe Area Wilderness Act,[1022] which ends logging, reduces motorboat use, phases out snowmobiling, expands the BWCAW by 68,000 acres, and accelerates the prohibition on mining. It also establishes the adjacent Mining Protection Area, withdrawing 222,000 acres "in order to protect existing natural values and high standards of environmental quality from the adverse impacts associated with mineral development."

1989 U.S. military agencies agree to re-draw the boundaries of a Military Operations Area (MOA) to eliminate noisy fighter-jet training flights above the BWCAW.

1991 MDNR, "in recognition of the BWCAW as a unique area of surpassing scenic beauty and solitude," withdraws certain state-owned lands from mineral leasing, including "small surface watersheds that flow directly into the BWCAW, within one-quarter of a mile of the BWCAW boundary, or principal recreational entrances and travel corridors entering BWCAW."[1023,1024]

1993 New U.S. Forest Service management plan for BWCAW reduces visitor quotas and moves management toward more wilderness-oriented approach.

2016 Minnesota Governor Mark Dayton directs MDNR not to authorize or enter into new lease or access agreements for mining on state lands near the BWCAW.

2016 Minnesota Pollution Control Agency rule revisions confirm BWCAW waters as "prohibited outstanding resource value waters," disallowing activity that results in "in a net increase in loading or other causes of degradation" to these waters.[1025]

2016 U.S. Forest Service denies consent to renewal of federal mineral leases needed for a proposed mine in the Rainy River-Headwaters.[1026] Thereafter, the BLM denies the company's request for renewal of the leases.[1027]

2017 U.S. Forest Service publishes Notice of Intent to prepare an EIS for its proposal to withdraw federal lands and minerals within the Rainy River-Headwaters from the federal minerals leasing program.[1028]

2021 U.S. Department of Agriculture and U.S. Department of the Interior announce that the Forest Service has applied for a mineral withdrawal to put federal lands

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[1020] 16 U.S. C. 1131-1136, Pub. L. No. 88-577, 70 Stat. 326 (Sept. 3, 1964).
[1021] Minn. Stat. § 84.523.
[1022] Public Law 95-495, 92 Stat. 1649 (Oct. 21, 1978).
[1023] MDNR (1991, April). *Operational Order 95*.
[1024] MDNR (1991, Feb.). *BWCAW Mineral Management Corridor*. [Map]
[1025] Minn. R. 7050.0265 subp. 7 and .0335 subp. 3.A.
[1026] U.S. Forest Service (2016, Dec. 14).
[1027] U.S. Bureau of Land Management (2016, Dec. 15a). *Decision.* U.S. Dept. of Interior.
[1028] U.S. Forest Service, Superior National Forest; Minnesota; Application for Withdrawal. 82 Fed. Reg. 4282 (Jan. 13, 2017).

and minerals in the Rainy River-Headwaters off-limits for 20 years to new mineral leasing and exploration permits.[1029] The Bureau of Land Management publishes a Notice of Intent initiating a two-year segregation and environmental review,[1030] and sends letters to two mining/ exploration companies denying their applied-for preference right lease application, prospecting permit applications, and requests for extension of existing prospecting permits in the Rainy River-Headwaters.[1031]

The proposed action is consistent with and the logical extension of the long history of federal, state, and provincial response to threats to the BWCAW and the rest of the Quetico-Superior region. The proposed action would provide the protection that has long been intended for the BWCAW from the impacts and risks of sulfide-ore copper mining, based on an understanding that has developed over the last three decades that these risks also arise from mining in upstream waters.[1032]

II. Strong support for protection from Minnesota government leaders

Several prominent Minnesota leaders share the sentiment of a majority of the state's citizens (as indicated in polling data discussed below). In March 2016, then-Governor Mark Dayton expressed his strong opposition to sulfide-ore copper mining on the edge of the BWCAW. In a letter to Twin Metals Minnesota, which had begun developing a mine plan for the Birch Lake-S. Kawishiwi River area, the Governor wrote:

> *As I told you, I have grave concerns about the use of state surface lands for mining related activities in close proximity to the Boundary Waters Canoe Area Wilderness (BWCAW). ... [M]y concern is for the inherent risks associated with any mining operation in close proximity to the BWCAW....*
>
> *As you know the BWCAW is a crown jewel in Minnesota and a national treasure ... I have an obligation to ensure it is not diminished in any way. Its uniqueness and fragility require that we exercise special care when we evaluate significant land use changes in the area, and I am unwilling to take risks with that Minnesota environmental icon.*[1033]

Governor Dayton directed the Minnesota Department of Natural Resources (DNR) not to authorize or enter into any new state access agreements or lease agreements for mining operations on state lands in the watershed of the BWCAW. He reaffirmed his opposition to the Twin Metals project in a March 22, 2016 commentary in the Mesabi Daily News:

[1029] U.S. Department of Agriculture. (2021, Oct. 20). Biden Administration takes action to complete study of Boundary Waters Area Watershed. [Press Release]. Retrieved December 1, 2021 from https://www.usda.gov/media/press-releases/2021/10/20/biden-administration-takes-action-complete-study-boundary-waters.

[1030] U.S. Bureau of Land Management, Notice of Application for Withdrawal and Segregation of Federal Lands; Cook, Lake, and Saint Louis Counties, Minnesota, 86 Fed. Reg. 58299 (October 21, 2021).

[1031] U.S. Bureau of Land Management (2021, October 21). Decision letters. U.S. Dept. of Interior.

[1032] *See* Part 1 of this comment for a digest of the authoritative agency and expert reports, journal articles, and NGO studies which form a partial basis for the more complete understanding today.

[1033] Dayton, M. Gov. (2016, March 6). Letter to Duckworth, I., Twin Metals Minnesota.

> [*T*]*he Boundary Waters Canoe Area does not belong just to Minnesotans. It belongs to all Americans, those living now and generations from now. Ely is not only its gateway, but also its guardian. That obligation to protect the BWCA and preserve its wilderness is a responsibility shared by all Minnesotans. We have no right to risk its vulnerable ecology for the financial benefit of a large international mining conglomerate and their Minnesota investors.*[1034]

Former Vice-President Walter Mondale shared Governor Dayton's determination to see the BWCAW protected, as he made plain in an April 1, 2016 commentary in the Minneapolis StarTribune:

> *Arizona has its Grand Canyon, Wyoming its Yellowstone, California its Yosemite. These wonders come to mind unbidden as images of a place when those states are named. The Boundary Waters is such an image for Minnesota. It is also our responsibility.*
> ...
>
> *We must do what Minnesotans before us have done: defend the wilderness.*
> ...
>
> *That means that today I join Minnesota's Gov. Mark Dayton and urge the federal land management agencies to continue the work of nearly 100 years and to ensure that the Boundary Waters wilderness remains the place it is today.*[1035]

More recently, in a message supporting the permanent protection of the Rainy River-Headwaters in order to prevent degradation of the BWCAW, former Vice-President Walter Mondale asked:

> *Are we generous enough, secure enough, mature enough to refuse short-term gain in order to avert long-term calamity?*
>
> *Our children's legacy depends on the answer.*[1036]

Congresswoman Betty McCollum cited the vast, clean waters of Voyageurs National Park and the BWCAW and the risk they face from sulfide-ore copper mining in announcing a bill to permanently protect their headwaters. The National Park and Wilderness Waters Protection Act would withdraw federal lands and minerals within the watershed of the BWCAW and the national park from the federal mineral leasing program. Rep. McCollum has stated:

[1034] Dayton, M. Gov. (2016, March 22). Gov. Dayton defends his decision. *Mesabi Tribune*. https://www.mesabitribune.com/opinion/columnists/gov-dayton-defends-his-decision/article_02c9f9c2-f09a-11e5-b9ef-9b835b2a86d9.html#//.

[1035] Mondale, W. (2016, April 1). Walter Mondale on fighting to save the soul of Minnesota: The Boundary Waters. *Minneapolis StarTribune*. https://www.startribune.com/walter-mondale-on-fighting-to-save-the-soul-of-minnesota-the-boundary-waters/371847051/.

[1036] Northeastern Minnesotans for Wilderness [Save the Boundary Waters]. (2021, October 19). *Former Vice President Mondale's Boundary Waters Legacy – Oct. 2021* [Video]. YouTube. https://www.youtube.com/watch?v=rrpIX6uffYA.

> *Voyageurs National Park and the Boundary Waters Canoe Area Wilderness belong to all of us as Minnesotans and Americans. It is worth protecting two special national treasures to make sure the next generation of Americans can enjoy their beauty, quiet, and pristine waters just as so many of us have.*[1037]

In reintroducing the Boundary Waters Wilderness Protection and Pollution Prevention Act, H.R. 2794, which would withdraw federal lands in the Rainy River watershed permanently from mining, said:

> *This wilderness protects a priceless reserve of water so clean that you can drink directly from the lakes. Water is the world's most critical natural resource, and it must be protected not only for today, but for future generations. The BWCAW is also a place of stillness and quiet that is unmatched anywhere else in the nation, and as the most-visited federal wilderness area in the country, it provides a refuge and source of adventure for millions of people….*[1038]

Minnesota's U.S. Senator Tina Smith has called the BWCAW, "the most precious resource we have," has praised former Vice-President Mondale for his efforts to protect the Boundary Waters, and has expressed optimism that "we will protect" the BWCAW. In March, 2021, Sen. Smith called on the Biden administration to restart the environmental review for a federal mineral withdrawal, saying:

> *…[C]opper-nickel mining is not right for all places. There are some places too sensitive to mine. This is why … the mineral segregation and withdrawal study is so essential.*[1039]

III. Strong public support for protection nationally and in Minnesota

a. Increased protection of the Boundary Waters from sulfide-ore copper mining has strong state support

The Forest Service should note the evidence showing strong public support for increased protection for the BWCAW. Polling results from two major polling firms – one commonly polling for Republican candidates and one that commonly polls for Democratic candidates – show that a strong majority of Minnesotans in every corner of the state and across party lines support protecting the Boundary Waters from the risk of sulfide-ore copper mining.

[1037] McCollum, B. (2015, April 14). Letter from Congresswoman McCollum to Constituents on National Park and Wilderness Waters Protection Act. [Press release]. https://mccollum.house.gov/press-release/letter-congresswoman-mccollum-constituents-national-park-and-wilderness-waters

[1038] Office of United States Congresswoman Betty McCollum (2021, April 22). McCollum reintroduces legislation to permanently protect Boundary Waters Canoe Area Wilderness from toxic mining pollution. [Press release]. Available online via: https://mccollum.house.gov/media/press-releases/mccollum-reintroduces-legislation-permanently-protect-boundary-waters-canoe

[1039] Lovrien, J. (2021, March 27). Smith to Biden admin- Restart the study on copper-nickel mining near BWCAW. *Duluth News Tribune*. https://www.duluthnewstribune.com/business/energy-and-mining/6956179-Smith-to-Biden-admin-Restart-the-study-on-copper-nickel-mining-near-BWCAW.

In February 2018 the polling firm of Fabrizio Ward conducted a statewide telephone of 800 registered voters in Minnesota, with oversamples of 300 registered voters in the second, sixth, and eighth Congressional Districts. A similar survey had been conducted by Fabrizio Ward in February 2017. For both the 2017 and 2018 poll, interviews were stratified into proportionate geographic units based on voter registration. The poll used language favored by mining proponents. For the 2018 poll, the margin of error at the 95% confidence level for 800 registered voters is 3.5% and 5.7% for 300 registered voters.

In 2017 Fabrizio Ward found that an overwhelming majority of Minnesotans are passionate about the Boundary Waters. Overall, 78% have a favorable opinion of the area, with an eye-popping 58% viewing it very favorably.

In 2018 Fabrizio Ward found that by a 48% margin, Minnesotan voters are against sulfide-ore copper mining in areas near the Boundary Waters (70% oppose / 22% favor). Voter opposition to sulfide-ore copper mining in areas near the Boundary Waters is growing. Opposition had increased by 11 points from the 2017 Fabrizio Ward poll, from 59% in 2017 to 70% in 2018.[1040,1041]

Opposition to sulfide-ore copper mining near the Boundary Waters extends to Congressional District 8 (CD-8), the location of the Boundary Waters and its watershed (the Rainy River Headwaters). Most voters (56%) in CD-8 are opposed to sulfide-ore coper mining in areas near the Boundary Waters.

Voters of all parties across the state and in CD-8 support a federal two-year pause to gather scientific information and public input about the potential effects of sulfide-ore copper mining near the Boundary Waters. Statewide, 78% support it, a net margin of 62 points (78%-16%).

In March 2016, Governor Mark Dayton issued a directive banning a Twin Metals sulfide-ore copper mining project near the Boundary Waters. Fabrizio Ward found that the Governor's directive was a popular one. Nearly two-thirds of Minnesota voters favor the Governor's ban of sulfide-ore copper mining in areas near the Boundary Waters. Support for the Governor's ban is intense with half of all voters saying they strongly favor the directive. A majority of voters in CD-8 favor the Governor's directive.

Voters are aware that outdoor recreation and public lands contribute to Minnesota's economy. Nearly nine in ten believe that the outdoor recreation economy, meaning people who come to hunt, fish, camp, see wildlife, as well as those who manufacture and sell equipment for those activities, are important to Minnesota's economic future. Furthermore, four in five voters say that due to the presence of public lands and the state's lifestyle of outdoor recreation, Minnesota has an advantage over other states in attracting good jobs and innovative companies.

[1040] Fabrizio, T., Ward, B., & Lee, J. (2018, March 18). Fabrizio Ward Memorandum re- sulfide ore copper mining near the Boundary Waters.
[1041] Fabrizio Ward (2018, April 10) *Save the Boundary Waters Telephone Survey, Findings* [PowerPoint presentation].

In July 2020, the polling firm ALG Research conducted a statewide poll of similar size. Based on this poll, it is clear voters in Minnesota want to protect the Boundary Waters from the potential dangers of sulfide-ore copper mining. Minnesotans are deeply connected to the Boundary Waters and, even in the context of the COVID-19 pandemic, are not willing to compromise its protection.[1042]

ALG Research found that voters in Minnesota oppose sulfide-ore copper mining on the edge of the Boundary Waters by a 39-point margin (62% oppose / 23% favor). Opposition to sulfide-ore copper mining on the edge of the Boundary Waters is both geographically broad and bipartisan. Democrats oppose by a 69-point margin; Independents by a 48-point margin; and Republicans by a 3-point margin. Voters in CD-8 oppose sulfide-ore copper mining on the edge of the Boundary Waters by a 10-point margin.[1043,1044]

ALG Research found that voters overwhelmingly support permanent protection for the Boundary Waters. More than two-thirds of the voters (68%) want the Boundary Waters permanently protected from threats such as sulfide-ore copper mining.

Finally, ALG Research found that the Boundary Waters is uniquely popular among Minnesotans. The area gets a 84% favorability rating, with a notable 66% very favorable. The positivity toward the Boundary Waters crosses geographic, demographic, and ideological lines and is bolstered by the view that outdoor recreation and tourism are significantly more important to Minnesota's economic future than mining (45% outdoor recreation and tourism / 10% mining / 35% both).[1045,1046]

In recognition of Minnesotans' love for the Boundary Waters, Governor Mark Dayton declared October 21, 2018, the 40th anniversary of the 1978 Boundary Waters Wilderness Act, as *Boundary Waters Canoe Area Wilderness Day.*[1047]

<u>Minnesotans strongly support the ban of sulfide-ore mining in the Rainy River Headwaters as necessary to protect the Boundary Waters.</u> Only a ban on sulfide-ore copper mining in the entirety of the Rainy River Headwaters will guarantee the protection of the great public lands and waters that the late Vice-President Walter Mondale called "Minnesota's Crown Jewel": the Boundary Waters Canoe Area Wilderness.

[1042] McCrary, Z., & Martin, L. (2020, July 20). *Minnesotans Strongly Oppose Mining at the Edge of the Boundary Waters*. ALG Research.
[1043] *Id.*
[1044] ALG Research (2020, July). *Boundary Waters Action Fund Poll Findings and Recommendations from Multi-Modal Minnesota Statewide Poll of Likely Voters* [PowerPoint presentation].
[1045] McCrary, Z., & Martin, L. (2020, July 20).
[1046] ALG Research (2020, July).
[1047] Dayton, M. Gov. (2018, October 21). Proclamation declaring Sunday, October 21, 2018 as Boundary Waters Canoe Area Wilderness Day.

b. Public comments previously submitted to the U.S. Forest Service strongly support a withdrawal to protect the watershed, the BWCAW, and other areas

The public in Minnesota and across the nation strongly supports withdrawing federal lands in the Rainy River-Headwaters outside of and upstream from the BWCAW, in order to protect the Withdrawal Area, the BWCAW, and the rest of the Superior National Forest and protected areas downstream, from the land conversion, contamination and inherent risks that sulfide-ore copper mining poses to water, wilderness, recreation, and other resources. In fact, an analysis of the scoping comments submitted directly to the USDA-Forest Service in 2017 shows that more than 98% of the 81,032 comments submitted then to the USFS supported the proposed Withdrawal.[1048] Supporters of the Withdrawal outnumbered opponents 55 to one.

C. The proposed mineral Withdrawal would not affect the nation's clean energy transition

It has long been the policy in the U.S. that some places, such as the Boundary Waters, are too special, sensitive, and beloved to mine. The Boundary Waters is the only significant lakeland wilderness in the U.S. and the most-visited wilderness area in the National Wilderness Preservation System, and has enormous international significance as the U.S. half of the trans-national Quetico-Superior ecosystem. The Boundary Waters is unique, beloved, irreplaceable, owned by all Americans, critical to the economy and life of the region, and accorded the highest levels of protection – strict non-degradation – of any area in Minnesota or the nation.

It is revered by Minnesotans, who consider it "Minnesota's Yellowstone."[1049] "Any damage to this fragile and unique ecosystem of interconnected waterways would be catastrophic."[1050] There is no social license in Minnesota or elsewhere to risk harm to the Boundary Waters by mining in its watershed. Luckily, the minerals that have been located in its watershed are not so rare or in such short supply that we need to consider degrading one of our nation's greatest treasures to obtain them.

The minerals needed for the clean energy transition are graphite, lithium, nickel, and cobalt.[1051] Although copper is also important to the new technology on which the transition depends, it is not listed as critical or in short supply because the U.S. and world resources of copper are plentiful and growing.[1052] The U.S. is among the top five copper producers in the world;[1053] we

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[1048] Wang, S. & Phillips, S. (2018). Full results from the review of comments on the proposed withdrawal of lands from mineral leasing in the Boundary Waters. Key-Log Economics. Prepared for Northeastern Minnesotans for Wilderness.

[1049] Dayton, M. Gov. (2016, March 6). Letter to Duckworth, I., Twin Metals Minnesota

[1050] Dayton, M.B. Gov. (2021, Dec. 1). Declaration of Mark B. Dayton, 40th Governor of the State of Minnesota

[1051] Scott, S. & Ireland, R. (2020, June 11). *Lithium-Ion Battery Materials for Electric Vehicles and their Global Value Chains*. U.S. International Trade Commission, Office of Industries. Retrieved December 12, 2021 from: https://www.usitc.gov/publications/332/working_papers/gvc_overview_scott_ireland_508_final_061120.pdf.

[1052] Mudd, G.M. & Jowitt, S.M. (2018). Growing global copper resources, reserves and production: Discovery is not the only control on supply. *Economic Geology 113*, 1235–1267. https://doi.org/10.5382/econgeo.2018.4590.

[1053] U.S. Geological Survey (2020). *Mineral commodity summaries 2020*. U.S. Dept. of Interior. https://doi.org/10.3133/ mcs2020.

have more than 25 mines producing copper, and experts see a low disruption potential for copper in the U.S. economy.[1054]

Lithium and graphite are not found in any meaningful quantities in the Duluth Complex. Accordingly, only cobalt and nickel are relevant to this discussion.

That being so, and as explained below, the minerals that would be produced in the Rainy River Headwaters would be irrelevant and insignificant to the U.S. clean energy transition.

I. Mines in the Rainy River-Headwaters would be irrelevant to the U.S. clean energy transition because their concentrates would be destined for foreign processing and markets

The following discussion focuses on Twin Metals, as it is farthest along in its planning process and has more information available than other potential mines in the Rainy River Headwaters. Twin Metals would produce metal concentrates, rather than refined metals. Concentrates are an intermediate product that must be smelted and processed before becoming refined copper or a battery precursor material such as nickel sulfate.

The U.S. has no copper smelter capacity for Twin Metals' copper concentrates. The U.S. has only three active copper smelters,[1055] and all three are fully integrated, meaning that their associated mines supply them with enough concentrate to keep them operating at full or near-full capacity. The U.S. currently has no nickel smelters and no nickel refinery.[1056] If Twin Metals goes forward with mining, it would ship its concentrates out of the U.S. to a third-party smelter.[1057]

Most likely the third-party smelter(s) will be in China. Antofagasta has been dealing with Chinese copper smelters since at least 2015.[1058] In 2019 Antofagasta replaced Freeport McMoRan as the lead miner negotiating benchmark treatment charge/refinement charges (TC/RC) after signing a deal with Chinese smelter Jiangxi Copper.[1059] Antofagasta currently sends all of its concentrates to Chinese smelters.[1060,1061] This is in part because China is the

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[1054] Nassar, N.T., Alonso, E., & Brainard, J.L. (2020). *Investigation of U.S. foreign reliance on critical minerals—USGS Technical Input Document in response to EO No. 13953 signed September 30, 2020, December 7, 2020.* [USGS OFR 2020–1127]. U.S. Geological Survey, Dept. of Interior.

[1055] U.S. Geological Survey (2021a). *Mineral commodity summaries: Copper.* U.S. Dept. of Interior. https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-copper.pdf.

[1056] U.S. Geological Survey (2021b). *Mineral commodity summaries: Nickel.* U.S. Dept. of Interior. https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-nickel.pdf.

[1057] Duluth Metals (2014, Oct.). *See* p. 25-6 ("The customers for TMM's nickel concentrate will likely be nickel smelters in North America, Europe, Russia, and China. China will be a potential market for the copper concentrates, along with other custom smelters in Europe and Asia.").

[1058] Xinhua Finance Agency (2015, Dec. 15). *Jiangxi Copper reaches agreement with Antofagasta Minerals on 2016 TC-RC.*

[1059] Luk, J. (2017, July 11). Comment: What next for copper TC/RC benchmark as Antofagasta begins breakaway? *Metal Bulletin.com*.

[1060] Daly, T. (2020, July 2). Antofagasta reaches early copper supply deals with China smelters. *Reuters.*

[1061] Daly, T. (2020, Dec. 18). Chile's Antofagasta agrees copper charges for 2021, sources say, Codelco to follow. *Reuters*.

biggest consumer of copper and other metals, but also indicates Antofagasta's prioritization of lowest-cost smelting and its level of comfort dealing with China. China is likely to dominate nickel smelting for the foreseeable future, even though many of its nickel smelters now operate in Indonesia. Although the number of nickel smelters worldwide is expected to double by 2024, most of those new smelters (many located in Indonesia) are commissioned and being built by the Chinese. The new smelters will have capacity that their owners are eager to fill, driving smelting prices down.[1062]

After shipment to foreign smelters, Twin Metal concentrates would become copper, nickel briquette or, after additional processing, a battery platform chemical like nickel sulfate. These are fungible commodities, indistinguishable from any other copper or nickel on the world market. Indeed, concentrates are often blended together at port facilities or at smelters.[1063]

There is no guarantee that any of the minerals Twin Metals would mine would ever wind up in the U.S. In fact, in renewing the federal leases for Twin Metals in 2019, the BLM removed a provision from the original 1966 leases that required an equivalent amount of metal mined from the deposits be returned to the U.S. as finished metal if the mine's products were sent overseas for smelting.[1064,1065] To the extent that metals from a Twin Metals mine might return to the U.S., it would be as a fraction of the metal in value-added products manufactured in China.

The origin of the atoms in the metal of a product is effectively unknowable, because again, copper and nickel are fungible products. One cannot look at a copper pipe or copper wiring or the insides of a battery in a car and know what mines in what countries produced those metal atoms, or even what smelter(s) or refinery(ies) those metals passed through on the way to your final product. In short, a Twin Metals mine would have no clear benefits on domestic mineral supplies to counter-balance the extreme risks it poses to the watershed.

II. The amount of contained metals in concentrates that would be produced in the Rainy River-Headwaters is insignificant compared with U.S. demand

Twin Metals' website and lobbying materials misleadingly suggest that minerals from its operations would supply a significant amount of U.S. or even global demand of the metals it will produce. For example, its website claims that "we have what the country needs," followed by graphics showing 34% of U.S. copper reserves, 95% of U.S. nickel reserves, and 88% of U.S. cobalt reserves.[1066] These numbers, intentionally or not, deceive even as they impress.

First, the figures conflate the deposits Twin Metals seeks to develop with the much larger Duluth Complex, which contains roughly 18 identified deposits, most of which Twin Metals has no claim to and/or are not in the Rainy River-Headwaters. For purposes of the Withdrawal study,

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[1062] Wulandari, F. (2021, Oct. 18). China's nickel producers step up investment in Indonesia. *Capitol.com*. https://capital.com/china-s-nickel-producers-step-up-investment-in-indonesia.

[1063] De Sousa, A. (2021, April 19). *Copper concentrate marketing 101*. AusIMM Bulletin. https://www.ausimm.com/bulletin/bulletin-articles/copper-concentrate-marketing-101/.

[1064] U.S. Dept. of Interior (1966). Federal Mineral Lease MNES-01352, Sec. 13(c).

[1065] U.S. Dept. of Interior (2019). Federal Mineral Lease MNES-01352.

[1066] *E.g.,* Twin Metals Minnesota (n.d.). *Why Minnesota.* Retrieved Nov. 27, 2021, from https://www.twin-metals.com/why-minnesota/.

the amount of metal that could theoretically be mined in the proposed Withdrawal Area is significantly smaller than Twin Metals' numbers seem to suggest.

Second, Twin Metals focuses on percentages of U.S. reserves, but U.S. reserves are small in comparison with U.S. consumption. U.S. reserves are also small in comparison with the reserves of our allies and close trading partners, Canada, Australia, and Norway, among others. For example, the U.S. hosts 0.7% of world cobalt reserves, while in pre-Covid 2019 claimed 8.7% of world consumption.[1067] Similarly, the U.S. hosts 1.3% of the world's PGM (platinum + palladium) reserves, while in 2019 claimed 32.2% of world consumption.[1068] And finally, the U.S. hosts just one tenth of one percent (0.1%) of world nickel reserves, while in 2019 claimed 8.3% of world consumption.[1069]

These details are important because without knowing the basis for a percentage, that percentage can look misleadingly impressive. Eighty-eight percent of a grain of sand is still less than a grain of sand.

Even if new smelter capacity were to be added in the U.S. (allowing minerals to stay in the country for processing), the amounts of contained metals in the concentrates that Twin Metals would produce are insignificant in comparison with U.S. consumption.[1070] Twin Metals states that it would produce 157,000 tonnes copper concentrate and 76,000 tonnes nickel concentrate annually.[1071] Mineral content of its concentrates can be found in its pre-feasibility report.[1072] Multiplying the tonnage of each yearly concentrate production by the assayed percent copper, nickel, and cobalt, and then combining the contained metals in the two concentrate streams, gives the total contained copper, nickel, and cobalt in annual production. Dividing each of these numbers by the U.S. apparent consumption in 2019 results in the following percentages: 2.3% of U.S. 2019 apparent copper consumption, 3.6% of U.S. 2019 apparent nickel consumption, and 1.5% of U.S. 2019 apparent cobalt consumption. If U.S. consumption of these metals rises for the next two decades as predicted, Twin Metal's percentage share would decline even farther. The simple fact is that the Twin Metals operation, even if it remains feasible, would not make a significant difference in regard to U.S. demand or the U.S. energy transition.

[1067] U.S. Geological Survey (2021c). *Mineral commodity summaries. Cobalt.* U.S. Dept. of Interior. https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-cobalt.pdf.

[1068] U.S. Geological Survey (2021d). *Mineral commodity summaries. Platinum group metals*. U.S. Dept. of Interior. https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-platinum.pdf.

[1069] U.S. Geological Survey (2021b). (Nickel).

[1070] Numbers used for consumption are for 2019 "apparent consumption," from U.S. Geological Survey (2020). Mineral consumption dropped during 2020 due to the Covid-19 pandemic. Final 2021 numbers are not available yet, but it is likely that 2020 numbers will be outliers, and that metals consumption will rebound and rise in coming years.

[1071] Twin Metals Minnesota (2019a), lines 220-221. ***N.B.*:** These annual concentrate production stream amounts were derived based on Twin Metals' assumption that its requested PRLA, MNES-57965, would be issued, but that PRLA was rejected by the BLM on October 21, 2021.

[1072] Duluth Metals (2014, Oct.), 13-35, Tables 13-17 and 13-18.

III. Our many close allies and trading partners are a source of U.S. strength and security, and provide a secure supply chain of critical and battery minerals

The U.S. can and does secure its supply chain of critical and battery minerals by importing them from a reliable and diverse set of trading partners, many of them long-time, close allies. The U.S. imports critical minerals from Canada, Mexico, Belgium, Germany, India, South Africa, the United Kingdom, Australia, Austria, Estonia, Japan, South Korea, Malaysia, and Rwanda.[1073]

According to the U.S. Geological Survey, the U.S. currently imports 57% of its cobalt needs from Canada, Norway, Japan, and Finland.[1074] Canada and Australia have a key strength -- sizable reserves of key battery minerals which the U.S. largely lacks. These countries have the ability to produce much more nickel and cobalt than they currently do, and much more than the U.S. will likely ever produce.[1075,1076,1077,1078] For example, Canada has more than 28 times the nickel reserves as the U.S. On average its nickel deposits are of double or higher grade than those in the U.S.[1079] Australia's are of similar scale and are of even higher grade on average, double those of Canada. As for cobalt, Australia alone has 83 deposits containing cobalt, 55 of which are of double or even higher grade than the Duluth Complex deposits. One of those deposits alone, if mined at a faster rate, has enough contained cobalt to supply the U.S. at current demand for more than 270 years. Another, the Murrin-Murrin mine, has nickel grades seven times the Maturi grade and cobalt grades five times the Maturi grade, and contains more than 40 times as much cobalt as a Twin Metals mine might produce.[1080]

Australia and Canada are eager to supply the U.S. with more battery chemicals and other critical minerals.[1081,1082] Canada's economy for many decades has been tightly integrated into that of the U.S., particularly in the automotive industry. Canada has the ability and desire to play an increasingly important role with the U.S. in expanding an integrated North American battery storage and EV manufacturing sector.[1083] This allows the U.S. to rely on our allied countries to supply us with the bulk of the metals needed for EVs and batteries, and to focus on processing

[1073] Nassar, et al. (2020).
[1074] U.S. Geological Survey (2021c). (Cobalt.)
[1075] *Id.* Canada, has more than four times as much cobalt reserves as the U.S., and Australia has more than 26 times as much.
[1076] U.S. Geological Survey (2021b). (Nickel.)
[1077] Jamasmie, C. (2021, May 19). Canada has "right ingredients" to be EV battery leader. *Mining.com.* https://www.mining.com/canada-has-right-ingredients-to-be-ev-battery-leader/.
[1078] Mudd, G.M. & Jowitt, S.M. (2014). A detailed assessment of global nickel resource trends and endowments. *J. Economic Geology, 109,* 1813–1841
[1079] *Id*., Table 3.
[1080] Mudd, G.M. (2009). Nickel sulfide versus laterite: The hard sustainability challenge remains. *Proc. 48th Annual Conference of Metallurgists*, Canadian Metallurgical Society.
[1081] Australian Govt. Dept. of Industry, Innovation, and Science (2019). *Australia's critical minerals strategy*.
[1082] Natural Resources Canada (2020, Jan. 9). Canada and U.S. finalize joint action plan on critical minerals collaboration. [Press Release].
[1083] Scherer, S. (2021, February 4). Canada's Trudeau eyes 'leaps forward' in integration with U.S. on EVs, critical minerals. *Reuters.* https://www.reuters.com/world/americas/canadas-trudeau-eyes-leaps-forward-integration-with-us-evs-critical-minerals-2021-02-04/.

them into batteries,[1084] reducing or avoiding reliance on China for EV components and expanding the U.S. position high in the battery minerals and manufacturing supply and value chain.[1085] It is important not to confuse import reliance with import vulnerability. The U.S.-Canada integrated EV and batteries sectors, like the existing automobile sector, would put U.S. national security at risk only if hostilities from our northern neighbor were an actual concern.

Given the extensive availability of high-grade minerals in our partner countries versus in the U.S., the idea that we should exploit every mineral deposit we have in the name of independence is the worst form of public policy. The call for mineral independence is a false construct that is being manipulated by the mining industry to convince the public and government officials to support projects that would otherwise be unsupportable.

IV. Alternatives and advances in battery cathode chemistries are eliminating nickel and cobalt in a large share of EV manufacturing

Deep investment in research and development will result in new dominant battery types and improved battery stability, safety, and energy density, but at present two lithium-ion battery types are dominant in the EV sector: nickel-cobalt-manganese (NCM),[1086] and lithium-ion-iron-phosphate (LFP). While the NCM type has higher energy densities, the LFP battery is gaining a larger share of Li-ion battery production because of its lower cost, higher cycle life, lower toxicity, and higher stability.[1087] In 2020 Tesla announced that Teslas manufactured in China would run on the LFP battery,[1088] and in 2021 the world's second-largest EV manufacturer, Chinas' BYD announced that it had gone nickel- and cobalt-free, as it switched entirely to LFP batteries.[1089] Ford Motors has announced that it is focused on LFP batteries as well.[1090]

BYD has touted improvements in its LFP battery technology that narrow the driving-range and charging-time gaps with NCM batteries. NCM will likely continue to be used in some long-range vehicles, but the availability of LFP for in-city commercial vehicles and shorter- to mid-range autos greatly reduces the amount of nickel and cobalt necessary to achieve the complete electrification of the transportation sector.

[1084] Scheyder, E., & Hunnicutt, T. (2021, May 25). Exclusive- Biden looks abroad for electric vehicle metals, in blow to U.S. miners. *Reuters.* https://www.reuters.com/business/energy/biden-looks-abroad-electric-vehicle-metals-blow-us-miners-2021-05-25/.

[1085] Mining.com (2021, Oct. 8). U.S. narrows gap with China in race to dominate battery supply chain – report. *Mining.com*. https://www.mining.com/us-narrows-gap-with-china-in-race-to-dominate-battery-supply-chain-report/.

[1086] Schmidt, D., Kamlah, M., & Knoblauch, V. (2018). Highly densified NCM-cathodes for high energy Li-ion batteries: Microstructural evolution during densification and its influence on the performance of the electrodes. *J. of Energy Storage, 17*, 213-223. https://doi.org/10.1016/j.est.2018.03.002.

[1087] Future Battery Industries CRC (2021). *Lithium-ion battery cathode manufacturing in Australia.*

[1088] Mining.com (2021, May 16). Tesla may be partnering with EVE, strengthening move toward LFP chemistries. *Mining.com.* https://www.mining.com/tesla-may-be-partnering-with-eve-strengthening-move-toward-lfp-chemistries/.

[1089] Mining.com (2021, April 13). World's no. 2 electric carmaker goes nickel, cobalt free. *Mining.com.* https://www.mining.com/world-no-2-electric-carmaker-goes-entirely-nickel-cobalt-free/.

[1090] Searcey, D., Forsythe, M. & Lipton, E. (2021, November 20). Race to the future - A power struggle over cobalt rattles the clean energy revolution. *The New York Times.* https://www.nytimes.com/2021/11/20/world/china-congo-cobalt.html?partner=IFTTT.

In summary, the U.S. can accomplish the clean energy transition without exploiting the virtually undeveloped Rainy River-Headwaters. Sacrificing this place to mining would make scant difference in the nation's supply of cobalt and nickel – which could soon be replaced by better battery systems anyway. Preserving the BWCAW and its watershed does not stand in the way of U.S. progress or of saving the planet from the worst ravages of climate change. To the contrary, preserving the most pristine natural areas that we have left is the real investment in America's future.

D. School Trust Lands

In the past, we have heard some mining company proponents assert that mining would deliver returns to the Minnesota School Fund. Even if true, it should have no bearing on a decision regarding the proposed federal lands Withdrawal.

The Withdrawal cannot and does not put Minnesota school trust land (STL) acres off-limits to mining. To the extent that the federal action might make mining less easy, or less affordable on some STL acres that are enclosed by federal lands, several points must be understood. First, it is not the responsibility of the US Forest Service or the Bureau of Land Management to manage National Forest land and federal minerals to maximize return from the Minnesota STL acres overlying the Duluth Complex.

Second, if by enclosing a small portion (2.9%)[1091] of STL acres the Withdrawal makes mining there less convenient or less immediately affordable, it in no way restricts timber harvest and other sustainable uses that return long-term value to the trust. Neither does it restrict future mining on the STL acres, though given the risks, the ubiquitous high-quality water, other resources, and other rights involved, any proposed sulfide-ore copper mining on those STL lands is and will always be dependent upon a host of other decision points.

Third, the State of Minnesota has previously put 5.2%[1092] of its STL acres into management categories effectively off-limits to mining. This proposed federal land Withdrawal finds good precedent in the State's and the U.S. Government's earlier actions, and it protects some of the biggest State investments in this regard, which were made to protect the waters in and flowing into the Boundary Waters.

Finally, sulfide-ore copper mining on STL acres (or U.S. Forest Service acres for that matter) could result in the trust (or the U.S. Treasury via the Forest Service) being held a "potentially responsible party" (PRP) under CERCLA. PRPs can be held partially liable for the costs of cleaning up mining waste. In a July 19, 2017 decision, the federal 10th Circuit Court of Appeals held the USA (Interior and USDA-Forest Service) to be a PRP and thus partially liable for hardrock mining waste cleanup costs likely to exceed $1 billion.[1093] The State and the trust

[1091] Disbrow, J. (2018, Feb. 14). Minnesota School Trust Lands- School Trust Lands Overlying the Duluth Complex. [MAP]. Northeastern Minnesotans for Wilderness.
[1092] Disbrow, J. (2018, Feb. 19). Minnesota School Trust Lands- School Trust Lands Overlying the Duluth Complex. [MAP]. Northeastern Minnesotans for Wilderness.
[1093] *Chevron Mining Inc. v. USA*, 863 F.3d 1261 (10th Cir. 2017); Available at: https://cases.justia.com/federal/appellate-courts/ca10/15-2209/15-2209-2017-07-19.pdf?ts=1500481887.

should consider that the mid-term liabilities from sulfide-ore copper mining could consume potential short-term gains, and would exclude other sustainable uses with a long-term record of returning value to the trust.

PART 5: COMPLIANCE WITH STATUTORY OBLIGATIONS

As described below, the Federal Land Policy and Management Act (FLPMA) gives the Interior Secretary, with consent of the Forest Service, broad discretion to make the proposed Withdrawal of approximately 225,378 acres of Superior National Forest lands in the Rainy River Watershed from disposition under the mineral and geothermal leasing laws. As documented in these comments, the Withdrawal is warranted to protect the world-class wilderness and watershed resources of the Boundary Waters Canoe Area Wilderness (BWCAW) and downstream protected areas from irreparable harm associated with exploration and development of sulfide-bearing mineral resources. Due to pending litigation and ongoing administrative review of the legality of Twin Metals' reinstated and renewed leases, the NEPA analysis for the proposed Withdrawal should not assume those leases constitute valid existing rights. However, the analysis should reflect that even in the unlikely event that the leases are ultimately considered valid existing rights, withdrawal remains the option best suited for protection of this unique ecosystem.

Given the significant public interest and potential impacts associated with this high-profile federal action, it is crucial that the Forest Service, as the lead agency, and BLM, as a cooperating agency, ensure robust yet efficient analysis under the National Environmental Policy Act (NEPA).

The Forest Service also must evaluate consistency with the 2004 Superior National Forest Land and Resource Management Plan. While the proposed Withdrawal is consistent with the forest plan, which did not contemplate or assume sulfide-ore mining, denial of the Forest Service's withdrawal application would require a significant forest plan amendment.

A. FLPMA withdrawal authority

I. FLPMA provides broad authority to make withdrawals

FLPMA gives the Interior Secretary broad authority to make withdrawals for almost any purpose – to "maintain other public values in the area" – so long as certain procedural requirements are followed. 43 U.S.C. §§ 1702(j), 1714. Contrary to statements made in the past, and likely to be advanced by Twin Metals and other opponents of the proposed action here, withdrawal is not an extreme, rarely utilized, or last-resort tool. In fact, for well over 100 years, both Congress and the executive branch have regularly withdrawn federal lands from a host of activities and uses to maintain a wide range of other public values. *See, e.g.*, *United States v. Midwest Oil Co.*, 236 U.S. 459, 470 (1915) (describing hundreds of executive withdrawals prior to 1910 for purposes ranging from protection of migratory birds to support for the military). This included three withdrawals, in 1902, 1905, and 1908, protecting 1.16 million acres of what is now the Superior

National Forest and BWCAW.[1094] FLPMA codified the executive branch's previously implied withdrawal authority and gave the Interior Secretary and certain delegated officials broad authority to withdraw large tracts (greater than 5,000 acres) of federal land for up to twenty years, subject to certain procedural requirements such as providing a public hearing and furnishing a report to Congress. 43 U.S.C. § 1714(a), (c) & (h). FLPMA also requires that the surface managing agency, here the Forest Service, consent to a withdrawal. *Id.* § 1714(i).

The Interior Secretary's broad withdrawal authority under FLPMA is consistent with Congress' stated objectives in enacting that statute, including ensuring that

> the public lands [would] be managed in a manner that [would] protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, [would] preserve and protect certain public lands in their natural condition; that [would] provide food and habitat for fish and wildlife and domestic animals; and that [would] provide for outdoor recreation and human occupancy and use.

Id. § 1701(a)(8). Indeed, the Secretary of the Interior, upon application by the Forest Service and the BLM, used its broad authority to withdraw Montana's Paradise Valley on the Custer-Gallatin National Forest from threats associated with mineral development. *See* 83 FR 51701. The stated purpose of that withdrawal, taken during the previous administration, was to protect and preserve the scenic integrity, important wildlife corridors, and high-quality recreation values. *Id*. Such values are the same as those implicated in Northeastern Minnesota.

The broad scope of FLPMA's withdrawal authority was utilized to protect another world-class landscape with irreplaceable resources—the watershed of the Grand Canyon— and was affirmed by the Ninth Circuit. *See Nat'l Mining Ass'n v. Zinke*, 877 F.3d 845 (9th Cir. 2017). In that case, the court upheld the Department of the Interior's withdrawal. The decision was based, in part, on its reasoning that even a small risk of groundwater contamination associated with uranium mining supported withdrawal of over 1 million acres of the Grand Canyon watershed, given the potentially catastrophic consequences associated with mine-related contamination and the need to take a "cautious and careful approach" where such unique resources were at stake. *Id.* at 859-60, 66-68. The court also deemed appropriate other justifications for the withdrawal, including safeguarding the cultural landscape sacred to numerous Native American tribes, protecting the area's scenery from dust and haze associated with anticipated mining activity, and reducing the risk that wildlife would suffer impacts associated with radioactive contamination. *Id.* at 868-70.

The *Zinke* court rejected claims that scientific evidence in the record did not justify the withdrawal, and that some disagreement or uncertainty about the potential risk of contamination or the socio-economic impacts of the withdrawal somehow rendered it invalid. *Id.* at 866-68, 870. It also rejected arguments that the withdrawal violated principles of multiple use and sustained yield. *Id.* at 872-73 (explaining that multiple use does not "preclude the agency from

[1094] Searle, R.N. (1977). *Saving Quetico-Superior – A Land Set Apart*. Minnesota Historical Society Press. 289pp. [Not included in Appendix].

taking a cautious approach to assure preservation of natural and cultural resources" and that "a particular parcel need not be put to all feasible uses or to any particular use").[1095]

BLM's analysis and withdrawal approval must demonstrate that: (1) the impacts associated with a proposed withdrawal are adequately disclosed and analyzed under NEPA, *see* 42 U.S.C. § 4332; (2) the decision is ultimately supported by the record, *see* 5 U.S.C. § 706(2)(A) (under the Administrative Procedure Act, a court may only set aside agency actions that are "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with the law" – a highly deferential standard of review); and (3) required information is provided to Congress, 43 U.S.C. § 1714(c)(2) (FLPMA provision enumerating certain information that must be furnished to Congress, enabling it to address the withdrawal legislatively if it so chooses). Those requirements can easily be met in this instance.

II. FLPMA withdrawal authority applies to mineral leasing on the Superior National Forest

As described above, the Interior Secretary enjoys broad authority to make withdrawals to maintain other public values and that authority has been and continues to be utilized to change the status of federal lands. The Interior Secretary has changed the status of public lands from available to unavailable for a wide range of reasons. Such activities, uses, or mechanisms for disposal include everything from homesteading, to grazing, to location and entry under the General Mining Law, to mineral leasing. These efforts are designed to maintain an even wider range of other public values – from geologic to watershed resources, to wildlife habitat, to recreational opportunities, to cultural and archaeological resources, all in the context of multiple use management of our federal public lands.

Commenters have previously addressed Twin Metals' arguments that administrative withdrawal of the acreage in the Superior National Forest would be illegal or outside the authority of the Department of the Interior. *See* February 28, 2018, Comment Letter of NMW et al., part 5, pp. 157-160. Twin Metals' arguments on these subjects contain multiple fundamental misstatements concerning the laws applicable to the Superior National Forest and withdrawals generally. *Id.* In anticipation that Twin Metals will make the same or substantially similar arguments now, Commenters address them below.

a. FLPMA withdrawal authority applies to mineral leasing

FLPMA withdrawal authority has consistently been held by the courts and interpreted by the agencies to apply to mineral leasing. *See id.*, p. 158; *see also*, *Pac. Legal Found. v. Watt*, 529 F. Supp. 982, 995-99 (D. Mont. 1981); Forest Service Manual 2822.2 (addressing withdrawals from mineral leasing); 65 Fed. Reg. 2423 (Jan. 14, 2000) (FLPMA withdrawal of Carlsbad Cave and Karst Area from mining and mineral leasing). As the court in *Pacific Legal Foundation* describes, there are no universally accepted or "traditional" meanings of the terms utilized in FLPMA's definition of withdrawal, 43 U.S.C. § 1702(j), and nothing to suggest that Congress did not intend for the authority to encompass mineral leasing. Mineral leasing is subject to

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[1095] The court also specifically held that FLPMA's unconstitutional legislative veto provision, 43 U.S.C. § 1714(c)(1), was severable and therefore does not affect the Secretary's withdrawal authority. *Id.* at 861-66.

significant discretionary control by the Interior Secretary and, in the Superior National Forest, by the Secretary of Agriculture as well. *See* 16 U.S.C. § 508b (requiring Forest Service consent for all mineral development and utilization on reserved public lands); Reorganization Plan No. 3 of 1946, 60 Stat. 1097, 1099 (requiring Forest Service consent to mineral activity on acquired national forest lands); 43 C.F.R. § 3503.13(a) & (c) (leasing decisions subject to Forest Service consent). FLPMA simply provides a process through which the Interior Secretary can decide not to lease certain lands through the more systematic and transparent withdrawal process – rather than through more piecemeal and ad hoc leasing and consent decisions.

b. The proposed Withdrawal is not an attempt to modify existing congressional withdrawals

Nothing in FLPMA prohibits new administrative withdrawals in the same area as a previous congressional withdrawal. And previous congressional withdrawals in no way preclude future congressional or administrative withdrawals in the same area. As set forth in the February 28, 2018, Comment Letter of NMW et al., part 5, pp. 158-159, the proposed action would withdraw for a period of twenty years a different area of the Rainy River Watershed than the BWCAW or Mining Protection Area, both of which were *permanently* withdrawn by Congress. Twin Metals has in the past made claims that the proposed Withdrawal is an attempt to modify the boundaries of prior statutory withdrawals of the BWCAW and Mining Protection Area, in violation of 43 U.S.C. § 1714(j). To the extent Twin Metals attempts to make the same arguments here, the claim remains entirely unsupported.

c. The proposed Withdrawal is entirely consistent with 16 U.S.C. § 508b and other congressional actions

The BWCAW Act expressed Congress' view that mining near the BWCAW would be harmful, but it did not address mining outside the Mining Protection Area. Contrary to the false narrative that has historically been advanced by Twin Metals that the balance of mining and conservation on the Superior National Forest has been definitively decided, the proposed Withdrawal is entirely consistent with and a logical extension of the long history of actions by Congress, the State of Minnesota, and the Forest Service designed to protect the BWCAW from various threats.

Twin Metals is likely to argue that the BWCAW Act of 1978 represented a definitive action that encouraged mining outside the wilderness and the Mining Protection Area and precluded additional protective measures, but taken to its logical end, such an argument would result in the absurd interpretation that FLPMA withdrawal authority does not apply wherever Congress has previously taken any action related to mineral development in the general vicinity.
Twin Metals has also made attempts to support its position by mischaracterizing 16 U.S.C. § 508b, claiming it expressly authorized mineral development on the Superior National Forest. As set forth in the February 28, 2018, Comment Letter of NMW et al., part 5, pp. 159-160, nothing in that statute requires mineral leasing or development or otherwise constrains the Interior Secretary's authority to make a withdrawal. In fact, because the statute disallows any mining activity unless the Forest Service consents to that activity, the statute very clearly does *not*

authorize mining across the forest. Any attempt to manufacture a conflict between 16 U.S.C. § 508b and the proposed Withdrawal fails.

d. The proposed Withdrawal is entirely consistent with agency policies and state expectations

The proposed Withdrawal is narrowly tailored to prevent otherwise irremediable contamination of the BWCAW's world-class watershed resources, and supports, rather than contradicts, state expectations and policies. Twin Metals has, in the past, made the absurd claim that non-binding agency guidance addressing mining as one of multiple uses it must balance somehow *requires* mining outside the BWCAW and Mining Protection Area. Where the Forest Service is legally obligated under the BWCAW Act of 1978 to protect and maintain the water quality of the wilderness and the Mining Protection Area, Pub. L. No. 95-495, § 9 (1978), and sulfide-ore mining in the BWCAW watershed will prevent it from doing so, any attempt to cherry-pick wilderness buffer language from non-binding agency guidance documents rings hollow. Moreover, the proposed Withdrawal would not create a buffer. While it would ensure protection of the watershed from irreparable harm associated with sulfide-ore mining, it would have no impact on other multiple uses, including motorized recreation, timber harvest, road building, or other intensive management activities and uses that are generally incompatible with wilderness.

III. The NEPA analysis of the Withdrawal should not assume the existence of any Twin Metals' valid existing rights

FLPMA gives the Department of the Interior Secretary broad authority to make withdrawals for almost any purpose – to "maintain other public values in the area" – so long as certain procedural requirements are followed, including that any such withdrawal be subject to valid existing rights. 43 U.S.C. §§ 1702(j), 1714. The proposed Withdrawal of approximately 225,378 acres of National Forest System lands in the Rainy River Watershed would prohibit the issuance of prospecting permits or leases for mining related activities – subject to valid existing rights – to protect the unique ecological area of Northern Minnesota from potential future sulfide mining. Twin Metals will likely assert that it has various valid existing rights, including leases MNES-01352 and MNES-01353, two preference right lease applications, and various prospecting permits and prospecting permit applications. Any such assertions are incorrect, and the Forest Service should not assume any valid existing rights for purposes of the NEPA analysis so that the full benefits of withdrawal on the Rainy River Watershed may be considered.

First, any claim that pending preference right lease or prospecting permit applications constitute valid existing rights is faulty. The BLM denied most of Twin Metals' pending applications upon initiation of the segregation, pursuant 43 C.F.R. § 2310.2(d).[1096] Any additional prospecting permits held by the company cannot constitute valid existing rights where issuance of any future preference right lease upon discovery of a valuable mineral deposit is a discretionary action that would be precluded by the proposed Withdrawal. *See* 43 C.F.R. § 3507.19 (Forest Service consent required prior to issuance of a preference right lease).

[1096] Thirteen additional prospecting permits, extended by the BLM on May 1, 2020, have been remanded and are being reconsidered by the agency and the U.S. Forest Service.

Second, the validity of the two leases held by Twin Mines remains the subject of ongoing litigation and Department of the Interior review. With the leases likely to be invalidated, the NEPA analysis should not assume they constitute valid existing rights under the proposed Withdrawal.

A brief history of the status of the leases provides critical context. On December 15, 2016, citing the Forest Service's denial of requisite consent, BLM declined to renew the two hardrock mineral leases. The Forest Service found that the development of a regionally untested copper-nickel sulfide ore mine within the same watershed as the Boundary Waters posed an unacceptable risk of serious and irreversible harm to this unique, iconic, and irreplaceable wilderness area. Letter from USFS Chief Tidwell to BLM Director Kornze (Dec. 14, 2016). Accordingly, BLM rejected the lease renewal application and the leases expired.

Although the 2016 BLM decision was reversed by the Trump Administration, and Twin Metals' leases were reinstated and subsequently renewed, those actions are being challenged in federal litigation. The renewal case is currently stayed pending a review by the Department of the Interior of two prior M-Opinions, the history of the prior lease renewals, and the NEPA review conducted in 2019. *See Wilderness Society et al. v. Bernhardt*, Case No. 1:20-cv-01176, Minute Order dated December 21, 2021 (noting that Interior is considering steps that could "significantly alter the contours of the instant case—or obviate the need to press forward entirely."). The reinstatement case is currently on appeal; there, the Department of the Interior moved for an extension of time to file their answering brief for the same considerations cited in the renewal case. *See Voyageur Outward Bound School, et al., v. United States of America et al.*, USCA Case No. 20-5097; Dkt. 1926595 (Opposed Motion for an Extension of Time to File Answering Brief) at p. 3. Because of their unlawful reinstatement and renewal, we do not believe Twin Metals' leases constitute valid existing rights, and the Forest Service should proceed with its NEPA analysis (discussed in the section below) with the assumption that there are no valid existing rights and a Twin Metals' mine will not be permitted.[1097] However, the analysis should reflect that in the unlikely event Twin Metals' leases are ultimately determined to be valid existing rights that might allow for permitting of a mine, withdrawal remains the most beneficial action to protect the Rainy River Watershed for all of the reasons cited throughout these comments.

B. National Environmental Policy Act compliance

The National Environmental Policy Act (NEPA) is "our basic national charter for protection of the environment." 40 C.F.R. 1500.1(a) (1978). NEPA's twin goals are to ensure informed agency decision-making and public involvement. *Robertson v. Methow Valley Citizen Council*, 490 U.S. 332, 349 (1989). Given the significant public interest and potential impacts associated with this high-profile federal action, it is crucial that the Forest Service, as the lead agency, and BLM, as a cooperating agency, ensure robust yet efficient analysis under the National Environmental Policy Act (NEPA).

[1097] This position is supported by the fact that Twin Metal's third preference right lease application, on which its December 2020 mine plan of operations relied, was denied upon initiation of the segregation. Subsequently, BLM rejected the company's mine plan of operations.

I. The Forest Service and BLM must fully comply with NEPA's mandates, despite ongoing regulatory uncertainty

In July 2020, the Trump Administration's Council on Environmental Quality (CEQ) issued a final rule overhauling its NEPA regulations. 85 Fed. Reg. 43,304 (July 16, 2020). The new regulations upend virtually every aspect of NEPA and its longstanding application, contradict decades of court interpretations of NEPA's mandates, and undercut reliance on NEPA by the public, decision-makers, and project proponents. They do so by narrowing the scope of actions to which NEPA applies, eviscerating the thorough environmental analysis and alternative development that lies at the statute's heart, reducing the public's ability to participate in decision making, and seeking to limit review of agency NEPA compliance. The new regulations went into effect on September 14, 2020. 40 C.F.R. § 1506.13 (2020). Five sets of plaintiffs challenged them in four different federal courts.[1098]

On his first day in office, President Biden directed federal agencies to review and reconsider regulations and other actions taken during the previous four years that conflict with important national objectives, including protecting public health and the environment, reducing greenhouse gas emissions, and prioritizing environmental justice. Exec. Order No. 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis* (Jan. 20, 2021). As a result of its review of the 2020 NEPA regulations, CEQ has initiated a series of regulatory actions designed to make "necessary revisions in order to comply with the law; meet the [administration's] environmental, climate change, and environmental justice objectives . . . ; ensure full and fair public involvement in the NEPA process; provide regulatory certainty to stakeholders; and promote better decision making consistent with NEPA's statutory requirements." Office of Information and Regulatory Affairs, RIN: 0331-AA05, https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202104&RIN=0331-AA05. First, on June 29, 2021, CEQ published an interim final rule extending the deadline in the 2020 rule that requires agencies to develop or revise their procedures to align with the new regulations. 86 Fed. Reg. 34,154 (June 29, 2021).[1099] Second, on October 7, 2021, CEQ published a proposed "Phase I" rule restoring several provisions of the 1978 regulations, including the requirement to analyze direct, indirect, and cumulative impacts, operation of CEQ's regulations as a floor, not a ceiling, and agency discretion to define purpose and need and alternatives beyond the narrow objectives of the project applicant. 86 Fed. Reg. 55,757 (Oct. 7, 2021). CEQ is currently working to finalize its "Phase I" rulemaking, while also beginning a broader "Phase II" rulemaking to meet the goals quoted above. Due to these regulatory actions, CEQ is likely to repeal several components of the 2020 regulations during the withdrawal study process and could potentially finalize a significant overhaul of the regulations prior to any final decision on the Forest Service's Withdrawal application.

[1098] *Alaska Cmty. Action on Toxics v. CEQ*, No. 3:20-cv-05199 (N.D. Cal. July 29, 2020); *Wild Va. v. CEQ*, No. 3:20-cv-00045 (W.D. Va. July 29, 2020); *Envtl. Justice Health Alliance v. CEQ*, No. 1:20-cv-06143 (S.D.N.Y. Aug. 6, 2020); *California v. CEQ*, No. 3:20-cv-06057 (N.D. Cal. Aug. 28, 2020); *Iowa Citizens for Cmty. Improvement v. CEQ*, No. 1:20-cv-02715 (D. D.C. Sept. 23, 2020).

[1099] The rule "allow[s] Federal agencies to avoid wasting resources developing procedures based upon regulations that CEQ may repeal or substantially amend," given CEQ's "substantial concerns about the legality of the 2020 Rule, the process that produced it, and whether the 2020 Rule meets the nation's needs and priorities."

In the meantime, the Forest Service's NEPA regulations at 36 C.F.R. part 220 – which were promulgated pursuant to and consistent with the 1978 CEQ regulations – continue to apply. While we are not aware of a USDA analogue, Interior Secretary Haaland has instructed BLM and other Interior Department agencies to "utilize the NEPA process to restore transparency and integrity to the decision-making process," including by "not apply[ing] the 2020 Rule in a manner that would change the application or level of NEPA that would have been applied to a proposed action before the 2020 Rule went into effect." Secretary of the Interior, Order No. 3399, § 5(a) (Apr. 16, 2021). In addition, the Department of the Interior's 2008 NEPA regulations at 43 C.F.R. part 46, which incorporate by reference the 1978 CEQ regulations, 43 C.F.R. § 46.20, remain in force and effect. Secretary Haaland's order further clarifies that agencies must "continue to follow" those Departmental regulations and should elevate any "irreconcilabl[e] conflicts" between the Departmental regulations and the 2020 CEQ regulations to the relevant Assistant Secretary and to CEQ. Secretarial Order No. 3399, § 5(a). The order also directs agencies to fully analyze greenhouse gas emissions and climate change impacts in their NEPA documents, as well as to conduct robust tribal consultation and environmental justice engagement. *Id.* § 5(b).

We believe the approach articulated in Secretary Haaland's order is sound (and understand that CEQ has issued similar oral guidance to agencies across the federal government) and recommend that the Forest Service follow a similar approach in conducting appropriate NEPA analysis on the proposed Withdrawal. Doing so will help reduce the chaos and confusion associated with the shifting and uncertain regulatory regime. Ultimately, the Forest Service must fully comply with NEPA's statutory mandates, including but not limited to conducting a thorough analysis of environmental effects, including "cumulative or synergistic" impacts and consideration of alternatives. 42 U.S.C. § 4332(2)(C) & (E); *Kleppe v. Sierra Club*, 427 U.S. 390, 410 (1976) (citing 42 U.S.C. § 4332(2)(C)).[1100]

II. The Forest Service should ensure meaningful public participation in the Withdrawal study process, including full consideration of previously submitted comments

Public scrutiny has long been understood to be essential to implementing NEPA. *See* 40 C.F.R. § 15000.1(b) (1978); *see also id.* § 1506.6 (1978) (directing agencies to provide for robust public involvement). Given the significant public interest and potential impacts associated with this high-profile federal action, the Forest Service, as lead agency, and BLM, as cooperating agency, should ensure ample opportunity for public participation throughout the Withdrawal study process, including by meaningfully considering and responding to substantive comments received. The agencies can also ensure a highly efficient process by relying on and fully considering previously submitted comments and oral testimony from the cancelled 2017-2018 withdrawal study process. That includes the approximately 98% of the more than 180,000 comments received during that study process supporting withdrawal, as well as the robust scientific record included in the technical comments submitted by NMW and others throughout the process and incorporated by reference herein.

[1100] *See also e.g.*, *Hanly v. Kleindienst*, 471 F.2d 823, 830–31, 836 (2d Cir. 1972); *City of Rochester v. U.S. Postal Service*, 541 F.2d 967, 972 (2d Cir. 1976) (citing *Scientists' Inst. for Pub. Info. v. Atomic Energy Comm'n*, 481 F.2d 1079, 1086–87 (D.C. Cir. 1973)).

III. The Forest Service must take a hard look at numerous impacts, particularly those associated with denial of the application for Withdrawal

NEPA requires federal agencies to take a "hard look" at the environmental consequences of proposed actions, including their direct, indirect, and cumulative effects. *Robertson*, 490 U.S. at 348; 42 U.S.C. § 4332(2)(C); 40 C.F.R. §§ 1502.16, 1508.7, 1508.8 (1978). The required hard look encompasses effects that are "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." 40 C.F.R. § 1508.8 (1978). The preceding parts of these comments provide detailed information about the affected environment – including the unique and irreplaceable resources of the BWCAW and surrounding national forest lands and their myriad social, economic, and ecological benefits – and the various issues and impacts – based on the best available scientific information – associated with the proposed Withdrawal and the no action alternative/denial of the withdrawal application that must be fully analyzed. The Forest Service's 2017 and 2021 withdrawal applications, as well as Forest Service Chief Tidwell's 2016 letter withholding consent to renewal of Twin Metals' leases also include detailed analysis of environmental and socio-economic issues and impacts associated with sulfide-ore mining activity in the Rainy River Watershed. The Forest Service must take the requisite hard look at these issues and impacts to determine the significance of effects and make a reasoned choice among alternatives.

Agency policies recognize that longer EAs may be necessary to address more complex proposals or where it will be difficult to determine whether there may be significant environmental effects. *See* 36 C.F.R. § 220.7(a) ("An EA may be prepared in any format useful to facilitate planning, decision making, and public disclosure . . . ."); Forest Service Handbook (FSH) 1909.15, ch. 40, §41.1 (length and detail of an EA may vary); BLM NEPA Handbook 8.1 (longer EAs appropriate in some instances); *but see* 40 C.F.R. § 1501.5(f) (2020) (prescribing arbitrary 75-page limit on EAs). It would be inappropriate in this case not to analyze a stand-alone no action alternative and instead integrate information about the current and future state of the environment in the absence of the proposed action into the environmental effects analysis – an approach that is sometimes appropriate for EAs. *See* 36 C.F.R. § 220.7(b)(2)(ii). Given the numerous significant environmental impacts associated with denial of the Forest Service's application for withdrawal, the Forest Service must analyze the no action alternative with the same level of treatment as the proposed action and any other action alternatives. *See* BLM NEPA Handbook 8.3.4.2 (supporting this approach if it will assist with decision-making by facilitating comparison of effects across alternatives and "demonstrat[ing] the consequences of not meeting the need for the action"). Absent a robust impacts and alternatives analysis, the Forest Service and BLM will lack necessary information to make an informed decision and to determine whether preparation of an EIS may be necessary.

Importantly, the Forest Service should not defer analysis of the reasonably foreseeable direct, indirect, and cumulative impacts associated with sulfide-ore mining until project-specific approvals, as Twin Metals is likely to request. There is significant and robust scientific information available to inform a comparative analysis of the impacts of the proposed Withdrawal with the impacts of the no action alternative. Neither the Forest Service nor the BLM have completed a NEPA process to determine at a programmatic level whether the Rainy River Watershed is an appropriate place for sulfide-ore mining and mineral leasing. If the answer to that threshold question is no – which we believe is unquestionably the case – then future site-specific environmental analysis (e.g., of Twin Metals' pending mine plan of operations or other leasing or permitting decisions) would be too little, too late. Chief Tidwell's December 14, 2016 letter withholding its consent to renewal of Twin Metals' two federal leases and the Forest Service's withdrawal applications each demonstrate the Forest Service's considered view that sulfide-ore mining in the BWCAW watershed would pose significant risks to the wilderness and other downstream resources that should be analyzed and addressed at a programmatic level using FLPMA's withdrawal tool. By contrast, under Twin Metals' approach, necessary environmental analysis would occur only after piecemeal determination of the location question through individual leasing decisions and after significant investment by a lease holder to develop a proposed mine plan (with corresponding pressure to approve the project). The analysis would also be focused only on the particular lease(s) or mine plan at issue. This is inadequate, because "NEPA is not designed to postpone analysis of an environmental consequence to the last possible moment. Rather, it is designed to require such analysis as soon as it can reasonably be done." *Kern v. U.S. Bureau of Land Mgmt.*, 284 F.3d 1062, 1072 (9th Cir. 2002).[1101]

IV. The Forest Service should carefully consider its range of alternatives

NEPA requires federal agencies to "study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." 42 U.S.C. 4332(2)(E); *see also* 40 C.F.R. § 1502.14(a) (1978) (an EIS must "[r]igorously explore and objectively evaluate all reasonable alternatives" to a proposed action); *id.* § 1508.9(b) (1978) (an EA must include a discussion "of alternatives as required by section 102(2)(E)"). Although "an agency's obligation to consider alternatives under an EA is a lesser one than under an EIS," NEPA "requires that alternatives be given full and meaningful consideration" in both instances. *Native Ecosystems Council v. U.S. Forest Serv.*, 428 F.3d 1233, 1245-46 (9th Cir. 2005). Forest Service regulations provide that EAs "shall briefly describe the proposed action and alternative(s) that meet the need for action. No specific number of alternatives is required or prescribed." 36 C.F.R. § 220.7(b)(2).

In general, we believe that the Forest Service can adequately analyze the proposed Withdrawal through a robust analysis of the no action alternative and the proposed action alternative. While the Forest Service could consider an intermediate alternative that would alter the acreage and/or length of the proposed Withdrawal, such an alternative would already fall within the range of the no action and proposed action alternatives. The agency should carefully respond to reasonable alternatives proposed by the public by either: (1) analyzing them, or (2) providing an explanation of why they will not be analyzed in detail. The agency need not analyze alternatives that are too remote, speculative, impractical, or ineffective at achieving the stated objective. *Theodore*

[1101] Moreover, as described earlier in these comments, project-specific reviews regularly fail to accurately predict violations of water quality standards and pollution limits that in fact occur. *See, e.g.*, Kuipers & Maest (2006), (hardrock mines sited near ground and/or surface water failed to accurately predict water quality standard violations roughly 9 times out of 10 – 85% near surface water and 93% near groundwater in areas of high acid mine drainage or contaminant leaching potential). And regulatory agencies routinely fail to address ongoing water contamination associated with acid mine drainage. *E.g.*, Spruce Road bulk sample site and Dunka Mine have been generating acid mine drainage since the 1970s.

Roosevelt Conservation P'ship v. Salazar, 661 F.3d 66, 72 (D.C. Cir. 2011). It may also reject alternatives that are not "significantly distinguishable from the alternatives already considered." *New Mexico ex rel. Richardson v. BLM*, 565 F.3d 683, 708-09 (10th Cir. 2009).[1102]

V. The Forest Service and BLM should conduct appropriate consultation with local governments

Under NEPA, federal agencies are required to "cooperate with State and local agencies to the fullest extent possible to reduce duplication between NEPA and State and local requirements." 40 C.F.R. § 1506.2(b) (1978); *see also id.* (2020) (similar language that also adds Tribal governments). Federal environmental analyses must also identify any inconsistencies of a proposed action with approved State or local plans or laws and "describe the extent to which the agency would reconcile its proposed action with the plan or law." *Id.* § 1506.2(d) (1978); *see also id.* (2020) (similar language adding Tribal governments). Similarly, FLPMA and the National Forest Management Act require coordination with State and local governments in the development of land use planning decisions. 43 U.S.C. § 1712(c)(9); 16 U.S.C. § 1604(a). Courts have routinely held that these obligations are satisfied where agencies provide opportunities for local government participation, consider and acknowledge local government concerns, and, as appropriate, analyze impacts to local economies or other issues raised by local governments. *See, e.g.*, *Nat'l Mining Ass'n*, 877 F.3d at 876-77; *Clearwater County v. U.S. Forest Serv.*, No. 1:13-CV-00519-EJL, 2017 U.S. Dist. LEXIS 93195, *20-23 (D. Idaho June 16, 2017) (noting that there is no requirement that the agency "choose the outcome preferred by [local governments]"; "[w]hat is required is that [the agency] provide notice and an opportunity for [local governments] to be involved in, comment on, and cooperated with during the process"); *see also Wyoming v. U.S. Dep't of Agric.*, 611 F.3d 1209, 1242-43 (10th Cir. 2011) (agency decision to grant or deny cooperating agency status to local governments is entirely discretionary). As the Ninth Circuit recently recognized:

> [T]he *consent* of state and local governments to a withdrawal is in no way required – and with good reason, as regional environmental threats must always be balanced against the economic gains the local governments could reap if no federal action were taken. NEPA does not confer veto power on potentially affected state or local governments, each with its own economic interests.

Nat'l Mining Ass'n, 877 F.3d at 877. The Forest Service and BLM should ensure a fair and robust public process that appropriately considers – but does not elevate over the broader public interest – the interests of local governments.

C. National Forest Management Act compliance and Forest Plan consistency

The National Forest Management Act (NFMA) requires that "[r]esource plans, permits, contracts, and other instruments for the use and occupancy of National Forest System lands shall be consistent with the land management plans." 16 U.S.C. § 1604(i). The proposed Withdrawal

[1102] During the previous withdrawal study process, Twin Metals proposed various alternatives to amend the forest plan and permit exploration activities to continue. Such alternatives are generally outside the scope of the proposed action and/or would not satisfy the stated objectives for the Withdrawal.

is entirely consistent with the 2004 Superior National Forest Plan, which did not contemplate, analyze, or anticipate sulfide-ore mining. Indeed, mining was identified among the "Issues Not Addressed in Detail" in the forest plan EIS, with active and anticipated mining activities focused only on gravel and granite. FEIS, p. 1-29. Unsurprisingly, the plan provides virtually no management direction for mining. *See* Superior National Forest Plan, p. 2-9 (providing minimal direction on mining); *see also id.* Appx. D (proposed and probable practices make no mention of mining activities). The proposed Withdrawal would largely maintain the no-anticipated-mining circumstances and expectations that informed the 2004 plan, and a plan amendment generally would be unnecessary. Any necessary clarifications to the current plan could be made via a narrow administrative change designed to ensure "conformance of the plan to new . . . regulatory requirements" associated with the Withdrawal. *See* 36 C.F.R. § 219.13(c). If the Forest Service determines that an amendment is necessary in the context of a withdrawal, it should be extremely narrow in scope. *See id.* § 219.13(a) (responsible official has authority to define the scope and scale of any amendment).

By contrast, a decision to deny the Forest Service's application for the Withdrawal would require a significant forest plan amendment (or potentially full plan revision) to reflect vastly changed circumstances and expectations. Since 2004, interest in sulfide-ore mining has grown, with significant exploration activities occurring under more than two dozen prospecting permits, numerous preference right lease and prospecting permit applications,[1103] and a Twin Metals' mine plan of operations on its two reinstated and renewed leases – the validity of which remain in dispute – and a third preference right lease application that has been denied. The numerous significant impacts associated with ongoing and reasonably foreseeable sulfide-ore exploration and mining activities under a no-withdrawal scenario were simply not analyzed or anticipated in the plan revision process resulting in the 2004 forest plan. As a result, a decision to deny the Forest Service's application for the Withdrawal and select the no action alternative would represent a significant change in circumstance since the 2004 forest plan and thus necessitate a forest plan amendment. Given the significant impacts of sulfide-ore mining on resources ranging from watershed to wilderness to wildlife to recreation, the scope of a forest plan amendment to address ongoing and reasonably foreseeable exploration, leasing, and mine development activities would need to be broad in the absence of a withdrawal. Importantly, the necessary amendment would directly implicate substantive requirements of the 2012 planning rule, including but not limited to the requirements to provide for ecological sustainability, including soil and water quality, 36 C.F.R. § 219.8(a), the diversity of plant and animal communities, *id.* § 219.9, sustainable recreation, *id.* § 219.10(b)(1)(i), and protection of congressionally designated wilderness areas, *id.* § 219.10(b)(1)(iv). *See id.* § 219.13(b)(5) (responsible official must apply substantive requirements determined to be directly related to the plan direction being altered by the amendment). Permitting sulfide-ore exploration and mining activity in the Rainy River Watershed would severely frustrate or prevent the Forest Service from ensuring compliance with those substantive requirements.

In addition to the overarching need for a forest plan amendment of significant scale and scope (or a full plan revision) to address sulfide-ore mining in the Rainy River Watershed, denial of the application for the Withdrawal would necessitate significant future legal compliance efforts by

[1103] Pursuant to 43 C.F.R. § 2310.2(d), BLM denied most – but not all – of the pending lease and permit applications on October 21, 2021, following initiation of the two-year segregation.

the Forest Service prior to consenting to approvals for prospecting, leasing, or mine plan operations. For instance, those mining activities would generally be inconsistent with the BWCAW Management Plan and other forest plan direction for a range of resources and multiple uses, in violation of NFMA.[1104] Such activities would also be inconsistent with state regulations which classify the BWCAW among "Prohibited Outstanding Resource Value Waters" subject to a strict non-degradation requirement that bars new or expanded discharges that would affect water quality. *See* Minnesota Rules 7050.0335 (2016).

Despite the fact that the 2004 forest plan clearly did not analyze, anticipate, or address sulfide-ore mining, Twin Metals has incorrectly claimed that the plan "endorsed" mineral development because mineral exploration and development outside the BWCAW and Mining Protection Area is a "desired condition" and "explicitly permitted." *See, e.g.*, Aug. 11, 2017 Comments by Dorsey, p. 12. These statements misunderstand fundamentals of forest planning, including that "desired condition" is Forest Service terminology for long-term, generalized goals that do not authorize any particular activities. *See Ohio Forestry Ass'n, Inc. v. Sierra Club*, 523 U.S. 726, 733 (1988). Thus, the forest plan desired conditions for minerals (D-MN-1 & D-MN-2) in no way compel mining activity on lands outside the BWCAW and Mining Protection Area or otherwise limit the Forest Service's authority to consent to a withdrawal of those lands (or to withhold its consent for a prospecting permit, mineral lease, or mine plan of operations, whether it be for gravel, granite, or sulfide-ore mining). Instead, they provide an overall vision of environmentally sound mineral development within the national forest – not mandatory constraints on Forest Service actions. Nothing in the plan suggests that mineral leasing in general – or sulfide-ore mining more specifically – was intended to occur in any place that was not already withdrawn as of 2004.[1105] The plan contains no standards or guidelines that would constrain the agency's authority to limit mining activity in areas outside the BWCAW or Mining Protection Area, whether through consent to a withdrawal or withholding of consent during any stage of approval under the applicable mineral leasing system.[1106]

D. The proposed Withdrawal is an essential step to ensure compliance with the Wilderness Act of 1964 and the Boundary Waters Canoe Area Wilderness Act of 1978

The Wilderness Act of 1964 (Public Law 88-577; 16 U.S.C. 1131-1136) ("Wilderness Act" or "1964 Act") affirmatively requires the Forest Service to preserve the Boundary Waters'

[1104] For instance, the BWCAW Management Plan, which was carried forward into the 2004 forest plan, requires the Forest Service to manage the wilderness "in a manner that perpetuates and protects its unique natural ecosystems, provides an enduring wilderness resource for future generations, and provides opportunities for a primitive and unconfined recreation experience." Superior National Forest Plan, p. 2-50; *see also id.* pp. 3-39 – 3-78 (specific wilderness management plan). The 2004 forest plan also includes extensive direction providing for the protection and sustainability of watershed health, riparian areas, soil resources (pp. 2-10 – 2-18), terrestrial and aquatic wildlife (2-27 – 2-36), tribal rights and interests (2-37 – 2-38), recreation opportunities (2-40 – 2-42), and scenic resources (2-45 – 2-48).

[1105] The Ninth Circuit has rejected an analogous argument – that a forest plan recommendation for withdrawal of certain areas impliedly granted mining rights throughout the remainder of the forest. *See Nat'l Mining Ass'n*, 877 F.3d at 878.

[1106] By contrast, the forest plan includes a standard *requiring* the Forest Service to provide sand and gravel for public and private use from within the Mining Protection Area. Superior National Forest Plan, p. 2-10 (S-MN-9).

wilderness character and values.[1107] This includes an obligation to protect the Boundary Waters from the effects of harmful activities outside of the wilderness boundaries.[1108] In light of the grave threat that sulfide-ore mining poses to the Boundary Waters' wilderness character and values, the proposed Withdrawal is an essential step to ensure compliance with the Wilderness Act.

The Wilderness Act established the National Wilderness Preservation System "to secure for the American people of present and future generations the benefits of an enduring resource of wilderness."[1109] The Wilderness Act designated the Boundary Waters Canoe Area among the original wilderness areas. It aimed to preserve and protect its lands and waters in their natural condition so they would be administered for the use and enjoyment of the American people and to preserve the wilderness character of the area, among other goals.

Section 1(c) of the Act defines wilderness:

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.[1110]

Section 4(b) of the Act requires each agency to preserve the wilderness character of any wilderness area it administers.[1111] This responsibility extends to activities occurring beyond the wilderness boundaries, but which degrade the wilderness character of a designated wilderness area.[1112] Federal actions that result in more intense, constant, or frequent pollution or disturbance, or pollution or disturbance of a different type or quality, are "more likely to degrade

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[1107] 16 U.S.C. § 1133(b).
[1108] *See Izaak Walton League of Am., Inc. v. Kimbell*, 516 F. Supp. 2d 982, 988 (D. Minn. 2007), judgment entered, No. CIV. 06-3357 JRT/RLE, 2008 WL 141728 (D. Minn. Jan 11, 2008) amended, No. CV 06-3357 (JRT/RLE), 2008 WL 11383666 (D. Minn. May 21, 2008), and aff'd, 558 F.3d 751 (8th Cir. 2009) (explaining, "the plain language of §[1133](b) makes no distinction based on the source of the allegedly degrading agency activity.").
[1109] 16 U.S.C. § 1131(a).
[1110] 16 U.S.C. § 1131(c).
[1111] *Id*. § 1133(b). This section provides: "Except as otherwise provided in this chapter, each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its wilderness character. Except as otherwise provided in this chapter, wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use."
[1112] *Izaak Walton League of America, Inc. v. Kimbell*, 516 F. Supp. 2d 982 (D. Minn. 2007).

wilderness character from its present condition and thus violate § 4(b)" of the Wilderness Act.[1113]

The Boundary Waters Canoe Area Wilderness Act of 1978 (Public Law 95-495; 92 Stat. 1649) ("1978 Act") granted additional protections to the Boundary Waters above and beyond those granted in the 1964 Act. For example, the 1978 Act established a Boundary Waters Canoe Area Mining Protection Area ("MPA") on 220,000 acres of Superior National Forest lands along roads extending toward the Boundary Waters, and banned all permits, leases, and authorizations for exploration or mining of federal-owned minerals in the BWCAW and MPA – thereby putting the lands permanently off limits to mineral exploration and mining.[1114] Additionally, the 1978 Act extended the ban for non-federal minerals to exploration or mining when they "may affect navigable waters."[1115] Protecting the Boundary Waters from harms posed by mining is a critical aspect of the Forest Service's duty; in fact, one of Congress' stated goals in the 1978 Act is to "minimize to the maximum extent possible, the environmental impacts associated with mineral development affecting" the Boundary Waters.[1116]

A primary purpose of 1978 Act was to safeguard the BWCAW and MPA from harmful impacts of mineral development. To that end, the 1978 Act provides clear management direction to the Forest Service, including to:

> "(1) Provide for the protection and management of the fish and wildlife of the wilderness so as to enhance public enjoyment and appreciation of the unique biotic resources of the region;
>
> (2) Protect and enhance the natural values and environmental quality of the lakes, streams, shorelines and associated forest areas of the wilderness;
>
> (3) Maintain high water quality in such areas; [and]
>
> (4) Minimize to the maximum extent possible, the environmental impacts associated with mineral development affecting such areas."[1117]

Mining, extracting, removing, and otherwise processing Duluth Complex ore in the Boundary Waters Watershed would have disastrous effects on the Boundary Waters, the MPA, and the Superior National Forest. As detailed in Parts 1, 2, and 3 *infra*, these effects include pollution and degradation of the existing high quality of the waters, lands, fish and wildlife, air, views, the acoustic environments, and other natural values of the Boundary Waters, MPA, and the Superior National Forest. Put simply, sulfur-ore copper mining inherently presents the potential for environmental harms that are incompatible with the Forest Service's duty to protect the

[1113] *Id*. at 990.
[1114] Pub. L. 95-495 § 11(a).
[1115] *Id.*
[1116] Pub. L. 95-495 § 2(4). While the 1978 Act aimed to protect the BWCAW from mining impacts and created the MPA, it was not a definitive Congressional statement about where mining is and is not allowed. The 1978 Act suggests no such intent, and withdrawal of additional areas outside the MPA is a logical extension of Congressional intent to ensure that the BWCAW is protected from mining impacts.
[1117] *Id*. § 2.

Boundary Waters and the surrounding areas.[1118] The proposed Withdrawal would offer critical protection against the risk of these disastrous effects of sulfide-ore mining.

Congress recognized that by putting most of the lakes in the Boundary Waters off-limits to motorboat use, the 1978 Act was restricting the highly-prized activity of dispersed motorized recreation in the scenic lakeland landscape of the Boundary Waters. Accordingly, and to partially offset the loss of such recreational opportunity in the Boundary Waters, the 1978 Act directs the Secretary of Agriculture to "expedite and intensify the program of dispersed outdoor recreation development on the Superior National Forest outside of the Boundary Waters," including "remote campsites on lightly developed lakes," among other things.[1119] The purpose of Section 18(a) of the 1978 Act is to ensure that the Superior National Forest areas outside of the Boundary Waters "provide motorized recreation experiences similar to those previously available in the Boundary Waters Canoe Area."[1120]

The proposed Withdrawal is crucial to achieving those goals. The Withdrawal Area provides exceptional opportunities for semi-primitive, near-wilderness recreational experiences, as discussed in Part 2, Section E above.

In conclusion, the Withdrawal is necessary for ensuring protection of important recreational areas near the BWCAW and Withdrawal area, and for ensuring protection of the BWCAW in accordance with the Forest Service's obligations under the 1964 and 1978 Acts. The 2021 Application for Withdrawal correctly notes that various mining impacts and potential mitigation or remediation efforts "could lead to irreversible degradation of this key water-based resource and jeopardize the purposes for the designation of the Boundary Waters and the MPA."[1121] Denial of the proposed Withdrawal would put both the Forest Service and BLM on a path towards non-compliance with federal agency obligations pursuant to § 4(b) of the Wilderness Act and §§ 2 & 18 of the 1978 Act. For reasons discussed above, and throughout this Comment, a denial of the Application for Withdrawal and the foreseeable consequences of doing so would contaminate rather than protect the fish & wildlife in the Boundary Waters and the MPA; diminish rather than enhance public enjoyment and appreciation of the unique biotic resources of the region; degrade the natural values and environmental quality of the lakes, streams, shorelines, and associated forest areas of the Boundary Waters and the MPA; and degrade rather than maintain the high water quality in the Boundary Waters and the MPA – all in violation of the 1978 Act.[1122] Moreover, these degradations, individually and in combination with each other, would impair the wilderness character of the Boundary Waters in violation of the Wilderness Act.[1123] As a result, this Application for Withdrawal is fully-warranted and should be granted.

[1118] *See* U.S. Forest Service (2016, Dec. 14). Letter from Tidwell, T., Chief, to Kornze, N., Director, Bureau of Land Management. U.S. Dept. of Agriculture (finding that sulfide-ore mining poses an unacceptable risk to the BWCAW and withholding consent to Twin Metals' proposed lease renewal.).
[1119] Pub. L. 95-495 § 18(a).
[1120] *Id.*
[1121] U.S. Forest Service (2021, Sept.). *Application for Withdrawal, Superior National Forest, Cook, Lake, and Saint Louis Counties.* U.S. Dept. of Agriculture. U.S. Dept. of Agriculture. *See* p. 3.
[1122] Pub. L. 95-495 §§ (2), (18).
[1123] 16 U.S.C. § 1133(b).

E. The Withdrawal is consistent with and supported by the Endangered Species Act

In enacting the Endangered Species Act ("ESA"), Congress declared its policy that all federal departments and agencies shall seek to conserve threatened and endangered species, and to utilize their authorities in furtherance of the purposes of the Act.[1124] Congress further defined "conserve" and "conservation" to mean the use of all methods and procedures which are necessary to bring any threatened or endangered species to the point at which the measures provided pursuant to the Act are no longer necessary.[1125] The Act then directs all federal agencies to utilize their authorities to carry out programs for the conservation of threatened and endangered species.[1126]

Shortly after the ESA was enacted, the U.S. Supreme Court emphasized the clear objectives of the Act the in *Tennessee Valley Authority v. Hill*:

> As it was finally passed, the Endangered Species Act of 1973 represented the most comprehensive legislation for the preservation of endangered species ever enacted by any nation. Its stated purposes were "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved," and "to provide a program for the conservation of such . . . species . . . ." 16 U. S. C. § 1531(b). In furtherance of these goals, Congress expressly stated in § 2 (c) that "all Federal departments and agencies shall seek to conserve endangered species and threatened species . . . ." 16 U. S. C. § 1531(c). Lest there be any ambiguity as to the meaning of this statutory directive, the Act specifically defined "conserve" as meaning "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary." § 1532(2).[1127]

The legislative history of the ESA "reveals an explicit congressional decision to require agencies to afford first priority to the declared national policy of saving endangered species."[1128] Congress intended "to give endangered species priority over the 'primary missions' of federal agencies."[1129]

The Withdrawal will help the Forest Service, U.S. Department of Interior, and BLM meet their obligations under the ESA to protect and recover threatened and endangered species, including the Canada lynx. The Withdrawal Area is critical habitat for lynx, which, as explained by the U.S. Fish and Wildlife Service, "is essential to the conservation of lynx because it is the only area in the Great Lakes Region for which there is evidence of recent lynx reproduction. It likely acts as a source or provides connectivity for more peripheral portions of the lynx's range in the region."[1130] The long-term protection of the Withdrawal Area, and exclusion from mining, could also serve as a key component in the required Recovery Plan for lynx, which is long

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[1124] 16 U.S.C. § 1531(c)(1).
[1125] 16 U.S.C. § 1532(3).
[1126] 16 U.S.C. § 1536(a)(1).
[1127] *Tennessee Valley Authority v. Hill*, 437 U.S. 153, 180 (1978).
[1128] *Id*. at 185.
[1129] *Id*.
[1130] 79 Fed. Reg. at 54824.

overdue.[1131] The Area also provides critically important habitat for the northern long-eared bat, which is being devastated by white-nose syndrome. And while not currently listed, the Area would provide important, safe habitat for moose and gray wolves, should they be added or re-listed under the ESA. The tremendous value of this Area for the survival and recovery of imperiled species will continue to increase as the impacts from climate change increase and become more severe. Additional discussion of the impacts of sulfide-ore copper mining on listed species and their habitat is found in Section 2, Part D.

F. Granting the application for withdrawal would protect air quality in furtherance of goals of the Clean Air Act

The Clean Air Act was enacted in order to protect public health and welfare nationwide.[1132] To achieve this purpose, it requires EPA to establish national ambient air quality standards ("NAAQs") based on the latest science.[1133] The Clean Air Act is also aimed at maintaining good air quality by preventing backsliding in so-called "attainment areas" where compliance with NAAQs has been achieved.[1134] To accomplish this, the Prevention of Significant Deterioration ("PSD") program, which determines any allowable margin of air quality deterioration, creates two tiers of protection: that provided Class I areas (the highest level of protection) and that provided to everything else.[1135] The proposed Withdrawal would advance the Clean Air Act's goal of protecting the public health and welfare. As the Application for Withdrawal recognizes, "it is well documented that hardrock mining like that which is proposed adjacent to the BWCAW poses risks to public health" due to pollution of air and water.[1136] By preventing hardrock mining in the Withdrawal Area, the proposed Withdrawal will protect the public from the deleterious air quality and other effects of sulfide-ore mining.

The Clean Air Act establishes the goal of restoring visibility in all Class I areas to natural conditions through the prevention of any future impairment of visibility[1137] and "the remedying of any existing impairment which results from manmade air pollution."[1138] Congress created the Class I designation, in part, to "preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value."[1139]

The Boundary Waters, Voyageurs National Park, and nearby Isle Royale National Park are all specially designated as Class I areas.[1140] As a result, Congress has explicitly determined that visibility is an important value in both of these areas that are adjacent to the proposed

1131 16 U.S.C. § 1533(f).
1132 42. U.S.C. § 7401(b)(1)
1133 42 U.S.C. § 7408.
1134 42 U.S.C. § 7407(d)(1)(A)(ii).
1135 40 C.F.R. § 81.401 - 81.437; 42 U.S.C. § 7473(b).
1136 U.S. Forest Service (2021, Sept.), p. 6.
1137 42 U.S.C. § 7491.
1138 U.S. EPA (2003). *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program*. EPA-454/B-03-005. U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Emissions, Monitoring and Analysis Division Air Quality Trends Analysis Group Research Triangle Park, NC.
1139 42 U.S.C. § 7470(2).
1140 40 C.F.R. §§ 81.414 – 81.415.

Withdrawal Area.[1141] In fact, given this special designation, "the maximum allowable increase in concentrations of . . . particulate matter over the baseline concentration" may not exceed 5 micrograms per cubic meter for the annual geometric mean, or 10 micrograms per cubic meter for the twenty-four-hour-maximum.[1142] These highly restrictive standards allow for only minimal degradation of air quality and impose substantial limitations on the amount of particulate matter that may be emitted and cause impacts in such areas. Because any potential sulfide-ore mining operations located within the proposed Withdrawal area would result in significant air pollution from fugitive dust, particulate matter, and other haze-forming pollutants, this Withdrawal is necessary to ensure the protection of the Class I air quality areas as called for by the Clean Air Act. Due to the strong potential for pollution and the highly restrictive standards applicable to the Boundary Waters and Voyageurs National Park, a denial of the proposed Withdrawal threatens to violate the Clean Air Act. Additional discussion of the impacts of mining air pollutants on visibility in the BWCAW is found in Part 2.E.

In addition to these threats to visibility within the airshed, sulfide-ore mining poses threats to air quality and public health through the release of various toxic compounds. Sulfide-ore mining releases toxic pollutants including mercury, lead, arsenic, asbestos, and particulate matter, all of which are chemicals of major public health concern.[1143] Through the release of these pollutants, sulfide-ore mining would pose a significant risk to downwind and downstream communities, as well as visitors to the BWCAW, Voyageurs National Park, and the surrounding areas. Additional discussion of the impacts of mining air pollutants on human health is found in Part 2.G.

G. The Withdrawal would provide essential protections in conformance with the Clean Water Act

The proposed Withdrawal is necessary to comply with the Clean Water Act's antidegradation standards as it will provide critical protections to these pristine waters. The Clean Water Act requires states to establish water quality standards for every body of water within a state.[1144] These standards include three components:

(1) designated uses for each body of water (e.g., recreational, agricultural, or industrial uses);

(2) specific limits on the levels of pollutants necessary to protect those designated uses; and

(3) an antidegradation policy designed to protect existing uses and preserve the present condition of the waters.[1145]

The antidegradation policy is further divided into three general levels of protection. "Tier I" establishes the minimum level of water quality that must be maintained in every body of water.[1146] "Tier II" applies to waters whose quality already exceeds the level "necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water," and only

[1141] 42. U.S.C. § 7491.
[1142] 42 U.S.C. § 7473.
[1143] These pollutants are all considered either "criteria pollutants" or hazardous air pollutants by the EPA. *See* 42 U.S.C. § 7408; *Id*. § 7412(b)(1).
[1144] *See* 33 U.S.C. § 1313.
[1145] 40 C.F.R. §§ 131.10-12.
[1146] *Id*. § 131.12(a)(1).

allows a reduction in quality when "necessary to accommodate important economic or social development."[1147] For a state's highest quality waters where ordinary use classifications may not suffice, "Tier III" prohibits any degradation of existing water quality standards with a limited exception for short-term or temporary changes in quality.

Waters falling into Tier III are designated "outstanding National resource waters" ("ONRW"). Where high quality waters constitute an ONRW, such as in National and State parks and waters with exceptional recreational or ecological significance, water quality must be maintained and protected.[1148] Per the Clean Water Act's antidegradation mandate set forth above, the state of Minnesota designated waters in the Boundary Waters and Voyageurs National Park as "outstanding resource value waters" (ORVWs).[1149] In Minnesota, ORVWs are further classified as either "prohibited" or "restricted." Prohibited ORVWs receive the highest level of protection, which prohibits any activity that results in a net increase of loading or other causes of degradation of these waters.[1150]

Put simply, absolutely no degradation can be allowed under the Clean Water Act for waters in or entering the Boundary Waters or Voyageurs National Park. For the reasons set forth in Part 2 describing the well-documented threat that sulfide-ore mining poses to water quality and aquatic resources in the watershed, the proposed Withdrawal is necessary to ensure compliance with the Clean Water Act's antidegradation standards. Because the Withdrawal Area of the Superior National Forest, the BWCAW, and Voyageurs National Park are all part of an interconnected water-intensive ecosystem, the consequences of a denial of the Application for Withdrawal may include violations of these antidegradation standards.

[1147] *Id.* § 131.12(a)(2).
[1148] *See Id*. § 131.12(a)(3); Water Quality Standards Regulation, 48 Fed.Reg. 51400-51403 (1983) (preamble).
[1149] Minn. R. 7050.0335, Subp. 3.
[1150] Minn. R. 7050.0265, Subp. 7. Per Minn R. 7050.0255, subp. 22, "Loading" means the quantity of pollutants, expressed as mass, resulting from a discharge or proposed discharge to a surface water. "Degradation" or "degrade" is defined as a measurable change to existing water quality made or induced by human activity resulting in diminished chemical physical, biological, or radiological qualities of surface waters. *Id.* 7050.0255, subp. 11.

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