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GREAT LAKES NATURAL RESOURCE CENTER®
*People and Nature: Our Future Is in the Balance*

June 19, 2006

Rebecca Harvey
Director, Region 5 UIC Branch
U.S. Environmental Protection Agency
77 W. Jackson Blvd.
Chicago, IL 60604-3507

Re: Kennecott mine in Marquette County, Michigan

Dear Ms. Harvey,

By this letter, the National Wildlife Federation formally requests that the United States Environmental Protection Agency (EPA) require that Kennecott Eagle Minerals Company (KEMC) obtain an individual Underground Injection Control (UIC) permit pursuant to 40 C.F.R. § 144.25(a) for its proposed mining activities in Marquette County in the Upper Peninsula of Michigan. The company's address and contact information are:

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Manager, Environment and Governmental Affairs
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The proposed project would be located in Sections 11 and 12, T50N-R29W, Township of Michigamme, Marquette County, Michigan, in an area known as the Yellow Dog Plains.

KEMC recently submitted applications for a nonferrous mining permit and a groundwater discharge permit to the Michigan Department of Environmental Quality (MDEQ). The applications and supporting documents can be found on the internet at: http://www.deq.state.mi.us/documents/deq-ogs-land-mining-metallicmining-EagleAppWeb.pdf. The information in this letter is drawn primarily from those applications. The contact person at MDEQ is:

Hal Fitch
Michigan DEQ

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KEMC's proposed mining activities include four types of groundwater disposal activities that are regulated under the EPA's UIC program. The first is the discharge of industrial wastewater into groundwater through a subsurface fluid distribution system, identified in permit application documents as the "Treated Water Infiltration System," or TWIS. The second is a nonresidential septic system with the capacity to serve more than twenty people per day. The third are several storm water holding basins designed to allow storm water to infiltrate to groundwater, which are referred to as "Non-Contact Water Infiltration Basins" or NCWIBs. The fourth involves the disposal of a number of different materials as backfill and for post-mine flooding of the underground mine workings. The backfill may include sludge or other semi-solids from various processes at the mine. Freshwater will be injected into the mine to accelerate mine filling for reclamation; the company may also inject treated water that has been pumped out of the mine to ensure acceptable groundwater quality at mine closure. The company also proposes to pump untreated waste water into the mine as a contingency measure if the contact water holding basins threaten to overflow. Our understanding is that EPA classifies these activities as Class V wells pursuant to 40 C.F.R. §§ 144.6 and 144.81.

Groundwater at and around the proposed mine site exists in essentially three layers. The first is the alluvial aquifer in the glacial deposits, the second is a freshwater layer in the upper bedrock, and the third is a briny layer in the lower bedrock. KEMC apparently takes the position that the freshwater layer in the upper bedrock is not an "underground source of drinking water" (USDW) according to the definition in the UIC regulations. It is therefore proposing to contaminate this groundwater with no set limits or standards.

We have four primary concerns in seeking EPA action. First, not enough testing has been done to determine that the upper bedrock should not be classified as a USDW. We believe that this aquifer should be protected as a source of fresh water. Second, processes at the mine may contaminate the alluvial aquifer. Mine plans do not include strict enough standards or monitoring to prevent this contamination. Third, the Salmon Trout River may be impacted due to its close hydrological connection with the alluvial aquifer. This river contains one of the last three native runs of coaster brook trout in the United States; a petition for listing this species as threatened or endangered was filed in February. Finally, the mine would fragment the largest contiguous wolf and Canada lynx habitat in the states of Michigan and Wisconsin. Wolves are listed as endangered and lynx are listed as threatened in these states. Additionally, the federally endangered Kirtland's warbler has recently been confirmed near the proposed mine site.

NWF requests that EPA require an individual permit for the activities described above pursuant to 40 C.F.R. § 144.25(a). As explained below, the TWIS, NCWIBs, and mine filling activities all have the potential to impact USDWs. These activities are as (or more) likely to cause ground and surface water contamination as are many wells for which EPA provides extensive requirements.1

1 If KEMC were correct in its position that the upper bedrock aquifer is not a USDW, the injection of freshwater, treated water, and untreated waste water as a contingency measure should be classified as Class I activities. *See* 40 C.F.R. § 144.6(a)(2) (Class I wells include "other industrial and municipal disposal wells which inject fluids beneath the

Yet as Class V wells, there are virtually no requirements that apply to them unless the EPA requires a permit. Thus an individual permit is needed because "the protection of USDWs requires that the injection operation be regulated by requirements, such as for corrective action, monitoring and reporting, or operation, which are not contained in the rule." 40 C.F.R. § 144.25(a)(3).

These UIC activities also have the potential to harm federally-listed threatened and endangered species. Requiring an individual permit would allow for consultation with the U.S. Fish and Wildlife Service (FWS) before the activity is federally authorized.

1. **The protection of USDWs requires that the injection operation be regulated by requirements that are not contained in the Class V rule.**

A description of the groundwater regime at the mine site can be found in the Environmental Baseline Summary, KEMC Mining Permit Application, Vol. 2, Appendix A, §§ 3.0 and 4.0. NWF is concerned about degradation of the alluvial and upper bedrock aquifers due to a number of mining activities. KEMC plans to discharge water into the alluvial aquifer through the TWIS system, through stormwater collection basins, and through a septic system. KEMC plans to discharge water into the upper bedrock aquifer through injection into the mine workings.

Three aspects of the proposed operation need regulatory requirements in order to protect underground sources of drinking water. First, operational parameters and monitoring and reporting requirements are needed to ensure that the upper bedrock aquifer is not contaminated by the extremely toxic water that will be contained within the mine workings after mine closure, and that the alluvial aquifer is not impacted by mixing between the bedrock and alluvial aquifers. Second, operational parameters and monitoring and reporting requirements are needed to ensure that water that infiltrates into groundwater from the NCWIBs remains in the pH neutral range and does not contain elevated levels of heavy metals. Third, monitoring and reporting requirements are needed to ensure that water that will contaminate the alluvial aquifer is not discharged through the TWIS or any other mechanism.

a. **Regulatory requirements are needed to protect the bedrock aquifer from contaminated water in the mine workings**

The groundwater in the upper bedrock (measured at 60 to 375 feet below surface in KEMC studies) has a total dissolved solids (TDS) concentration ranging from 168 to 287 mg/L,2 and thus would be considered a USDW if it contains a sufficient quantity of water. See 40 C.F.R. § 144.3. KEMC has not done enough testing to eliminate this as a USDW, but intends to allow this water to become contaminated from its mining activities.

i. *KEMC has not done enough testing to determine that the bedrock aquifer should not be classified as a USDW.*

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lowermost formation containing, within one quarter mile of the well bore" a USDW.) If regulatory requirements are needed to protect USDWs from fluids injected *beneath* them, it defies logic that no regulatory requirements are needed to protect USDWs from fluids injected directly *into* them, as may be the case here.

2 Mining Permit Application Vol. 2, Appendix B-3 (Phase II Bedrock Hydrogeologic Investigation) Table 9.2 (attached as Exhibit 1).


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Although KEMC discounts the upper bedrock as having too low a permeability to qualify as a USDW, the company has not done enough testing to make this determination with any certainty. Only one pumping test and four packer tests were performed in the entire bedrock aquifer. Information on the packer tests is presented in the Mining Permit Application, Vol. 2, Appendix B-2 (Bedrock Hydrogeologic Investigation) § 4. The packer tests were done in boreholes that apparently did not intersect fractures at the upper levels,3 despite the assessment that the upper bedrock is relatively highly fractured due to weathering. *See* Mining Permit Application Vol. 2, Appendix A (Environmental Baseline Study) § 4.3.1. These tests resulted in an estimated hydraulic conductivity of $2 \times 10^{-08}$ m/s, which should be taken only as an estimate of conductivity through the unfractured rock. Furthermore, it should be noted that these values are inferred from tests of the entire boreholes, extending as low as 990 feet, and are an average measure of conductivity to about 330 feet. *These tests do not provide estimates of conductivity at 257.4 or 159 feet, the depth below surface of the highest proposed level of the mine. 4 One* additional test was done at a fractured location, which showed a mean hydraulic conductivity of $1.4 \times 10^{-08}$ m/s. *See* Mining Permit Application Vol 2, Appendix B-3 (Phase II Hydrogeologic Investigation) § 7.

At least one residence in the vicinity of the proposed mine draws its water from a bedrock well. This well, which is located about three miles north of the mine, is 282 feet deep. Records provided by KEMC do not include information about the pumping capacity of this well. Groundwater Discharge Permit Application Appendix C.

KEMC has not provided borehole core logs or other information on the extent of fractures or joints observed during drilling. It is thus not possible to assess whether the boreholes selected for packer tests and the pumping test are representative of fractures and weathering in the upper bedrock. Either more testing or more disclosure of data is needed to determine whether the upper bedrock should be classified as a USDW, and thus should be protected under the federal UIC program.

*ii. Under the proposed plan, the upper bedrock aquifer will become contaminated.*

KEMC does not intend to protect the upper bedrock aquifer. In its mining permit application, KEMC states several times that the only aquifer that the mine is designed to protect is the alluvial aquifer. The application contains neither estimates of nor proposed limits to apply to the water quality in the upper bedrock aquifer.

The upper bedrock aquifer is certain to be impacted because the mine workings will extend into this aquifer. Although the permit application is unclear on this point, it appears that the ceiling of the mine may be as high as 159 feet below the surface, and will certainly be as high as high as 257 feet below surface. These elevations are well above the level at which KEMC found freshwater in the bedrock.

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3 For instance, the test in borehole 04EA-84 shows higher conductivity at a fractured location in the lower bedrock than in the upper bedrock, leading us to assume that the upper bedrock area was not fractured. *See* Mining Permit Application, Vol. 2, Appendix B-2 (Bedrock Hydrogeologic Investigation) § 4.13.

4 Various documents propose the highest mining level at 357.5 and 387.5 meters above mean sea level, equivalent to 1172.6 and 1271 feet, respectively. The surface elevation is approximately 1430 feet MSL.


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After mine closure, the mine will fill with highly contaminated water, and this water will reach into the upper bedrock aquifer. The predicted "composite mine drainage water" that KEMC will pump and treat during operations is found the Groundwater Discharge Permit Application, Table 4 (attached as Exhibit 2). We have been unable to locate predicted water quality in the mine after mining ends, but believe that water collecting in the mine would be as bad or worse than that pumped out during operations. This water would violate Michigan's drinking water standards for antimony, boron, cadmium, chloride, cobalt, iron, lead, manganese, mercury, nickel, selenium, and sodium. *See* Michigan R. 299.5744.

This extremely poor water quality will not be solely the result of poor water quality that currently exists in the lower bedrock. For instance, nickel in the lower bedrock groundwater has been measured at 25 ug/L; mine drainage predictions are for 36,425 ug/L. (The drinking water standard is 100 ug/L.) Antimony has been measured in the lower bedrock groundwater at 5 ug/L; mine drainage predictions are for 21 ug/L. (The drinking water standard is 6 ug/L.) Cobalt has been measured in the lower bedrock groundwater at 10 ug/L; mine drainage predictions are for 730 ug/L. (The drinking water standard is 40 ug/L.)

Although KEMC implies throughout its application materials that this mine water will have no connection to freshwater aquifers, that connection will exist in the workings of the mine itself. The ore is proposed to be mined in an alternating stope system. The ore will first be removed from primary stopes, leaving the secondary stopes intact. The primary stopes will then be filled with cemented aggregate, providing the structure to mine the secondary stopes. The secondary stopes will be backfilled by placing loose (uncemented) waste rock that has been stored on the surface (and thus exposed to precipitation and oxygen) back into the mine. Although this waste rock will be amended with limestone to reduce its acid-forming capability, the amount of buffering capacity that would be needed to neutralize the rock is essentially undeterminable, and thus the limestone amendment has not been calculated to eliminate acid formation, but simply to reduce it by an undetermined amount.

The resulting configuration of the mine workings after closure will consist of alternating walls of cemented aggregate and openings filled with uncemented reactive waste rock. Water from groundwater inflow and from pumping freshwater into the mine will fill the spaces within the uncemented waste rock. Acid will generate and heavy metals will leach from both the waste rock and the host rock surrounding the mine opening.

The interface between the upper, freshwater bedrock aquifer and the lower, briny aquifer will be well within the uncemented areas of the mine workings. Although KEMC does intend to place cement plugs to isolate the lower bedrock aquifer from the upper bedrock aquifer in openings that reach into the alluvial aquifer, such as ventilation and transportation shafts, these plugs are intended to protect only the alluvial aquifer. Within the mine workings, the upper freshwater and lower brine will be able to mix freely.

KEMC has stated that it will pump and treat the water from the upper bedrock aquifer as needed *to protect the alluvial aquifer*. No standards are proposed for final water quality in the upper bedrock aquifer, and no proposal has been made to protect that aquifer. Although KEMC opines that this pump-and-treat program will not be "perennial," it provides no estimate of the likely timeframe before the program is no longer needed.


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KEMC is also including as a contingency plan the possibility of pumping contaminated water into the mine, in the event that the waste water treatment plant becomes temporarily inoperational or is unable to handle the volume of wastewater. This could occur if inflow into the mine is heavier than predicted or if precipitation and snowmelt events lead to an unexpected volume of runoff in surface areas where contact with sulfide-bearing rock occurs. For some parameters, this water will be worse than the mine drainage water. For instance, the arsenic level is predicted to be 83 ug/L (the drinking water standard is 50 ug/L), and the sulfate level is predicted to be 575 mg/L (the drinking water standard is 250 mg/L). Groundwater Discharge Permit Application Table 4-2. The permit applications give no details on either the injection or the removal of this contaminated water.

*iii. The water filling the mine after closure will be as toxic as waste that is defined as "hazardous" under the UIC regulations.*

Waste of this quality from any other industry besides mining cannot be disposed of within a USDW, because it is defined as "hazardous." Although the waste rock and sludge from waste rock and contact water holding areas may be excluded from the definition of "hazardous waste" because it is mining waste, as noted above it will form an extremely toxic mixture within the mine workings. This water will be no less toxic simply because it does not meet the legal definition of "hazardous waste." It presents exactly the same concerns for contamination of USDWs as would a UIC well for the disposal of hazardous waste with the same constituency. Hazardous waste disposal wells are subject to extensive construction, operation, monitoring, closure, and financial assurance requirements if they are injected below USDWs, *see* 40 C.F.R. Part 144, subparts E and F and 40 C.F.R. Part 146, and are prohibited if they are injected into USDWs. 40 C.F.R. § 144.13.

There is no question that this project will result in extremely contaminated water directly underneath a USDW, water that would be considered hazardous waste if it stemmed from any industry other than mining. If the above requirements are necessary to protect USDWs from hazardous waste, they are equally necessary to protect USDWs from the waste here.

As the EPA is well aware, the history of the mining of sulfide ores is a history of ground and surface water contamination. Some of the country's worst Superfund sites are the result of the same processes that will pollute the groundwater in Marquette County if this project is permitted as it is currently proposed. While we appreciate the fact that it was a congressional decision not to treat mining waste as "hazardous" under the Resource Conservation and Rehabilitation Act, Congress did *not* intend that mining waste would be treated differently than other waste under the Safe Drinking Water Act. *See* H.F. Rep. No. 1185, 93rd Cong., *reprinted in* 1974 U.S. Code Cong. & Admin. News 6454. We ask the EPA to protect the aquifer under the Yellow Dog Plains to the same extent that it would protect an aquifer that was threatened by a non-mining industry.

**b. Regulatory requirements are needed to protect the alluvial aquifer from contaminated water in the mine workings**

KEMC's conclusion that there will be no upward or lateral movement of contaminated water from the mine workings within the bedrock into the glacial till and alluvial aquifer are not supported by sufficient testing. KEMC has done a very minimal amount of testing to assess an upward gradient from the bedrock into the alluvial aquifer; its conclusion that this potential does


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not exist is unwarranted based on the information it has presented. Its analysis is presented in the Phase II Bedrock Hydrogeologic Investigation, Mining Permit Application Vol. 2, Appendix B-3, § 10.

Furthermore, KEMC has provided little information on lateral movement of water through the upper bedrock, which is subject to far greater fracturing than the lower bedrock. The distance below surface to the bedrock in the mining area varies from 0 to about 240 feet. *See* Mining Permit Application Vol. 2, Appendix B (Hydrogeology Reports), Figures 12 and 13. The distance to the water table varies from 0 to about 120 feet. *Id.,* Figure 23. KEMC has provided no assessment of the interaction between the groundwater in the bedrock and the alluvial aquifer as the bedrock rises closer to the surface.

KEMC's position that there is little connection between the bedrock and alluvial aquifer is unsupported by its own background information. For instance, the Phase II Bedrock Hydrogeologic Investigation report states:

> Groundwater sampled from 05EA-107 has overall lower TDS concentrations that decrease at the shallower interval. The sample collected at the shallower 18.20 to 34.90 m interval has similar anion chemistry to the Quaternary deposits, 5 falling between the bedrock and Quaternary deposit chemistry with respect to anions and cations, as shown on the Piper diagram in Figure 9.1. The anion-cation signatures indicate that at this shallow interval the groundwater may be influenced by both bedrock and Quaternary deposit groundwater. Combined with the lower TDS of both bedrock borehole samples, these factors indicate that some water from the Quaternary deposit may influence or dilute the TDS concentrations at both depths, though the specific mechanism of influence this cannot be determined using chemistry alone.

Mining Permit Application Vol. 2, Appendix B-3, § 9.2.3.

KEMC also ignores the potential for increased underground fracturing from blasting and subsidence that might open pathways for groundwater movement that do not currently exist. Although the mining application repeatedly states that there will be no noticeable subsidence at the surface, it does not claim that there will be no subsidence at levels that do not reach the ground surface. KEMC appears to be asking the DEQ to permit mining at levels at which the strength of the crown pillar has not yet been determined, which could result in insufficient safeguards for this key barrier between the alluvial aquifer and contaminated water in the mine workings. Also, although increased fracturing due to blasting is not expected to extend into the bedrock to a significant depth, at the upper elevations of the mine these fractures could increase the potential for connections between the bedrock and alluvial aquifers.

**c. Sufficient monitoring is needed to ensure that the alluvial aquifer is protected from surface operations**

While the company plans to discharge only water that meets drinking water standards through the TWIS, the planned monitoring system is insufficient to know that this goal will be met. In addition, there is potential for acidic water with high metals levels to leach into the ground from a variety of holding, processing, and transportation areas, as there is at any mine site processing

5 The alluvial aquifer is referred to as the "Quaternatry deposits" in permit application materials.


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ores that are very high in sulfides. Monitoring plans are also insufficient to ensure that such leaching is discovered.

KEMC's planned monitoring system can be pieced together from the Mining Permit Application Vol. 1, Figure 6-1 (Operations Groundwater Quality Monitoring System) and the Groundwater Discharge Permit Application Figure 7-1 (Treated Water Infiltration System Layout and Details). The TWIS monitoring system consists of four monitoring wells, three to the northeast and one to the southwest of the discharge. The operations system consists of four wells to the east of the Temporary Development Rock Storage Area (TDRSA) and two to the east of the Contact Water Basins (CWBs).

We are concerned about the absence of monitoring wells to the north or south of these facilities. The TWIS will result in a large cone of groundwater that (at least initially) flows radially from the discharge point. The septic system, which is located between the TWIS and the TDRSA, will also result in a groundwater cone, which has not been factored in to the company's hydrological studies or modeling. Discharge from the Non-Contact Water Infiltration Basins also has not been adequately considered in assessing the potential groundwater flow changes. All of these factors are likely to affect the groundwater flow direction under the mine facilities, with the result that the planned wells may not detect contaminated effluent or groundwater.

Finally, the estimate of groundwater drawdown in the mine workings is based on extremely sketchy data. If that estimate proves incorrect, both the cone of depression at the mine and the cone of elevation at the TWIS will be much larger than has been modeled, with potentially significant changes in groundwater flow.

**d. Regulatory requirements are needed to ensure that the Non-Contact Water Infiltration Basins do not contaminate the alluvial aquifer**

KEMC will be routing stormwater from areas of the surface facilities that do not contact waste rock or ore into Non-Contact Water Infiltration Basins (NCWIBs), where the water will infiltrate naturally into the alluvial aquifer. While at first glance this seems relatively benign, there is substantial potential for this water to be low in pH and high in dissolved metals. KEMC does not plan any monitoring of the water quality in the NCWIBs.

A large amount of soil will be disturbed and stockpiled during construction of the facility, and will continue to be contacted by precipitation throughout the life of the mine. Some of this material is quite low in pH and high in metal content. The precipitation will then be directed to the NCWIBs, where it will be allowed to infiltrate to groundwater.

According to the mining permit application,

> The testing indicates soil pH conditions in the northwest quarter of Section 12[6] of the study area are naturally acidic. Soil pH values ranged from 4.2 to 6.6.
>
> The soil study found that local concentrations of some metals in the project area soils are naturally elevated with respect to statewide averages. At some locations, concentrations

6 The main surface facilities are located entirely within Section 12.


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exceed MDEQ-published Statewide Default Background Concentration levels specified in R 299.5746. . . .

The area around the outcrop was shown to have naturally elevated levels of metals and acidic conditions in the soil due to the presence of naturally occurring sulfide minerals and their weathering products. Naturally occurring metal concentrations tend to be associated with the lowest soil pH values. The five samples with pH values of less than 4.8 yielded the highest concentrations for 23 of the 48 metals tested. One sample accounted for 13 of those 23 maximum concentrations.

Mining Permit Application Vol. 2 § 3.3.1. Soil sample metals concentrations and pH levels are found in *id.,* Appendix C, Table 3 (attached as Exhibit 3). Several of the highest metals concentrations are an order of magnitude larger than the MDEQ Statewide Default Background Concentrations.7

An enormous amount of earth clearing and moving will be required to construct the surface facilities. Buildings alone will cover 62,000 square feet. Mine Permit Application Vol. 1, Table 4-7. Earth movement will involve 251,300 $yd^3$ of soil. *Id.* Table 4-3.

Although KEMC does propose to follow storm water BMPs in construction activities, it is relying on the collection of storm water in the NCWIBs to avoid discharges to surface water. Given the low pH of the disturbed soils, we expect that the water standing in these basins will also exhibit a low pH and will continue to leach metals from the surrounding soil prior to and during infiltration. These leached metals from the holding basins will be added to high metal levels already contained in runoff. Yet KEMC has no plans to monitor this water, or to treat it if that should prove necessary.

**2. An individual UIC permit is needed to protect the habitat of threatened and endangered species.**

The proposed KEMC mine site sits in the center of the largest unbroken block of wolf habitat in Michigan and Wisconsin. *See* Mladenoff, David J., Theodore A. Sickley, Adrian P. Wydeven, and Robert G. Haight, "Regional Landscape Analysis and Predictionof Favorable Gray Wolf Habitat and Population Recovery in the Northern Great Lakes Region," http://www.timberwolfinformation.org/info/wolves/wolf.htm, accessed April 28, 2006 (hereinafter, *Mladenoff*) (attached as Exhibit 4). Such large areas of habitat are critical to wolf recovery and for any potential recovery of other large predator mammals, such as Canada lynx and cougars.

The proposed mine would also be located underneath the upper reaches of the Salmon Trout River, and the surface facilities would be located in its headwaters. The Salmon Trout River is home to the last remaining native run of coaster brook trout on the South Shore of Lake Superior, and one of the last three remaining native runs in the United States.

Additionally, the endangered Kirtland's Warbler has been confirmed in near proximity to the proposed mine site and transportation route. Kirtland's warblers are increasing in number in

7 These are the standard levels for remediation of contaminated sites, unless it can be shown that higher levels are naturally-occurring. Michigan R 299.5746.


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Michigan's Upper Peninsula, with some birds even nesting in the U.P. Portions of the Yellow Dog Plains, including near the proposed mine site and transportation route have been identified as prime habitat for the birds. The presence of the Kirtland's warbler invokes the protection of the Endangered Species Act and the United States Fish and Wildlife Service.

**a. EPA must consult with the Fish and Wildlife Service before authorizing a project that may jeopardize a listed species.**

Pursuant to the Endangered Species Act, EPA must consult with the Fish and Wildlife Service before authorizing any activity that might jeopardize the continued existence of an endangered or threatened species. 16 U.S.C. § 1536(a)(2). The initial requirement is that EPA request information from FWS as to "whether any species which is listed or proposed to be listed may be present in the area of [the] proposed action." *Id.* § 1536(c)(1). Whenever the FWS concludes that an endangered or threatened species *may be present* in the area, the EPA "shall conduct a biological assessment for the purpose of identifying any endangered species or threatened species which is likely to be affected by [the] action." *Id.*

Pursuant to regulations promulgated by FWS, consultation is required for "all actions in which there is discretionary Federal involvement or control." 50 C.F.R. § 402.03. In this situation, EPA has the discretion to control UIC activities at the proposed mine site, and thus must follow the consultation requirements and procedures.

**b. Wolves are likely to present at the site, and the mine would destroy and fragment important wolf habitat.**

The gray wolf is currently listed as endangered in the states of Michigan and Wisconsin. Although FWS proposed delisting the wolf in these states on March 16, 2006, that action has not yet gone through the public review process and no final decision has been made.

Wolf recovery in Michigan and Wisconsin has closely followed the existence of large areas with low road densities, which correlates highly with sparse human settlement and activity. Although the wolf population in Wisconsin and Michigan now exceeds 400 animals in each state, Wisconsin's leading wolf authority believes that Wisconsin may not have sufficient habitat with low road density to maintain a population without a continuing source from outside the state. According to Prof. Mladenoff, "Potential wolf habitat in upper Michigan occurs in larger, more contiguous blocks than in Wisconsin. This area could maintain a significant wolf population that would be capable of serving as a source for Wisconsin, should increased development and fragmentation make wolf movement across northern Wisconsin more difficult." *Mladenoff.*

The proposed KEMC mine site sits in the center of the largest contiguous block of wolf habitat in the states of Michigan and Wisconsin. *See id.* However, the Environmental Impact Assessment (EIA) prepared for the mine project by KEMC pursuant to Michigan law virtually ignores the impact of the mine on wolf and other wildlife habitat. Noise, traffic, lights and human presence will all be factors that make the area unattractive to wolves; none of these factors are assessed by the EIA. It is unclear at this point whether MDEQ will do any additional analysis of the impacts of the mine on wolf habitat.

Wolf researchers have found a very high correlation between areas with low road densities (such


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as the Yellow Dog Plains) and the presence of wolf packs in Wisconsin and Michigan. *See Mladenoff.* Based on this research, it is very highly likely that wolves are present at the mine site and in the near vicinity. While KEMC did not find evidence of wolf activity on the site, its study of only seven transect lines is insufficient to conclude that wolves do not use the site and do not use the larger area that will be affected by noise, lights, and traffic. The biologists who did the study did not conclude that wolves are absent from the actual site. *See* EIA Appendix E.8

As Michigan's wolf management plan states, "[T]he survival of wolves and other species with large home ranges is best assured by maintaining some large tracts of land with relatively low human densities and accessibility. Future land management will require careful planning at the landscape level to maintain sufficient quantity and proper distribution of suitable wolf habitat." Michigan Department of Natural Resources, Michigan Gray Wolf Recovery and Management Plan v, Dec. 15, 1997.

Thus far, the mine permitting process has been the opposite of "careful planning at the landscape level." In fact, we see no indication yet that the Michigan DEQ intends to view this project at the landscape level at all. While NWF agrees that the wolf population in the Midwest has increased to the point where it should be considered for delisting, we also feel strongly that delisting should only occur if the states show that they will manage wolf populations and habitat to ensure species viability. NWF supported the downlisting of wolves from endangered to threatened in Michigan and Wisconsin in 2000. As we stated in our comments at that time, however, "NWF will not support delisting based on the number of wolves alone. Rather, NWF's support will be contingent on further improvements in state management plans that have already been developed in Michigan and Wisconsin, and the adoption of a satisfactory plan by Minnesota." Michigan now must improve and utilize its state management plan to protect wolves and their habitat in this instance, if NWF is to support delisting.

It is too early to assume that wolf habitat in Michigan does not need to be protected by the federal government. We stand to see the largest block of wolf habitat in two states fragmented, with impacts from noise, traffic, and human activity extending to an undetermined distance. It is imperative that FWS have the opportunity to consult on federal authorization of activities such as the underground injection of waste, to ensure that any measures that could mitigate the impact of this mine on wolf habitat are taken.

**c. The mine area is suitable habitat for Canada lynx.**

Canada lynx are also listed as threatened in Michigan. Although the proposed designation of critical habitat does not include habitat in Michigan, this is not because such habitat does not exist, nor because lynx are not found in Michigan. Rather, it is based on the judgment of the Fish and Wildlife Service that Michigan is less likely to sustain a breeding population because of the lack of direct land connection to Canada and because most sightings have not been verified by qualified experts.9 Nonetheless, the Federal Register notice of proposed critical habitat designation states,

---

8 This assessment does not fulfill federal agency obligations because it was not done in cooperation with FWS and under the supervision of EPA. *See* 16 U.S.C. § 1536(c)(2).

9 It should be noted that Minnesota has a specific program to verify lynx sightings, while Michigan does not.


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> Areas that support populations, but are outside the critical habitat designation, will continue to be subject to conservation actions implemented under section 7(a)(1) of the Act and to the regulatory protections afforded by the section 7(a)(2) jeopardy standard, as determined on the basis of the best available information at the time of the action. Federally funded or permitted projects affecting listed species outside their designated critical habitat areas may still result in jeopardy findings in some cases.

70 Fed. Reg. 68294, 68297 (Nov. 9, 2005).

The critical elements of Canada lynx habitat are:

> Boreal forest landscapes supporting a mosaic of differing successional forest stages and containing:
> (a) Presence of snowshoe hares and their preferred habitat conditions, which include dense understories of young trees or shrubs tall enough to protrude above the snow; and
> (b) Winter snow conditions that are generally deep and fluffy for extended periods of time; and
> (c) Sites for denning that have abundant coarse woody debris, such as downed trees and root wads.

*Id.* at 68300. The Yellow Dog Plains area meets all of these critical elements. For a description of habitat at the site, *see* Mining Permit Application Vol. 2, Appendix F-1 (Threatened and Endangered Species Report).

Once again, KEMC's study of only seven transect lines across the mine site is insufficient to conclude that lynx do not use the site and do not use the larger area that will be affected by noise, lights, and traffic. Individual Canada lynx have a home range of from 13 to 83 square miles. 70 Fed. Reg. at 68297. Few places in Michigan retain this much contiguous habitat; the Yellow Dog Plains is one of them.

**d. The mine threatens the last remaining run of coaster brook trout on the south shore of Lake Superior.**

Coaster brook trout are an anadramous brook trout (*Salvelinus fontinalis*) that spend their early years and return to spawn in cold water streams, but live much of their lives in the open waters of the Great Lakes. These fish were historically found in as many as 118 tributary streams of Lake Superior. Newman, L.E., R.B. DuBois, and T. N. Halpern (eds.), *A brook trout rehabilitation plan for Lake Superior*, Great Lakes Fish. Comm. Misc. Publ. 2003-03 (May 2003). They may also have historically inhabited streams in Lake Huron and northern Lake Michigan, but have been completely extirpated from these lakes. Of at least seventy-five U.S. streams that historically contained native populations, only three remain – one of which is the Salmon Trout River. KEMC's proposed mine would be excavated underneath the upper reach of the Salmon Trout River, about eight miles upstream of the coaster brook trout population.

Although the coaster is not yet listed under the federal Endangered Species Act, a petition for listing was filed on February 23, 2006, by the Sierra Club Mackinac Chapter, the Huron Mountain Club, and Marvin Roberson (attached as Exhibit 5)(hereinafter, *Petition*). We have every expectation that the species will be listed and that the Salmon Trout River will be designated as critical habitat, as the Fish and Wildlife Service has recognized the fragile state of


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the species and the importance of maintaining all remaining strains for many years. According to the FWS 1999 Coaster Brook Trout Broodstock Development Plan, "Coaster brook trout populations have been extirpated or severely reduced from all U.S. waters of the Great Lakes. Surveys at Isle Royale National Park (IRNP), Michigan, conducted by the Service have found that while remnant populations of coaster brook trout exist, the size of these populations is very small." In fact, the number of strains and the population in the wild is so small that the FWS follows protocol for genetics management for threatened and endangered fish species in its broodstock program. *See* Quinlan, H., D. Bast, R. Gordon, and J. Collins, *Coaster Brook Trout Broodstock Development Plan*, U.S. Fish and Wildlife Service (April 19, 1999).

Mining sulfide ores immediately upstream of one of the last remaining runs of coaster brook trout presents a number of threats to this species. As only three or four distinct population segments remain, every native run is critical to the survival of the species.

The mining of sulfide ore *always* presents the potential for acid drainage and the resulting leaching of heavy metals. The ore as well as the waste rock in this case are extremely high in sulfides, with much of the ore higher than 80% sulfide. This material will be separated, crushed, transported, and stored on the surface. While the mining company of course has containment plans, it is inevitable that reactive dust and rock will escape in some way. Furthermore, as described above, KEMC will disturb a large area of low-pH soil. Many surface facilities will contain very acidic water, as will the mine workings after closure. Some of this water, along with precipitation that contacts escaped dust and rock or the disturbed, low-pH soils, is bound to make its way into the groundwater.

The groundwater in this area has a known hydrologic connection to the Salmon Trout River. The groundwater vents to the surface through seeps located less than one mile north of the mine site. These seeps contribute a large percentage of the flow to the lower reach of the Salmon Trout River.

KEMC has proposed groundwater standards for the area that will allow some acidification of the groundwater, with a resulting allowance of a decrease in the pH level of the Salmon Trout at the point of venting. Background sulfate levels in the alluvial aquifer have been calculated at 4.18 and 8.43 mg/L. Under the proposed mining plan, groundwater would be allowed to degrade to 250 mg/L sulfate. Although KEMC does not *plan* to discharge sulfates at this level, no action will be required if leaks, spills, and discharge through the TWIS result in the degradation of groundwater to something less than 250 mg/L sulfate. The current sulfate level in the Salmon Trout River is xx; the surface water quality standard is xx.

As explained in the petition for listing,

> Acidic water has been shown to have detrimental effects on all brook trout, and are particularly toxic to post-emergent fry and pre-smolts. (Watt, 1987; Mills, 1989; Lansky, 1992). Eggs and alevins are highly sensitive to acidification and are likely to be killed at levels below 4.5 pH. Low pH interferes with reproductive functions of the brook trout, including delayed or inhibited hatching of eggs. Respiration, gill performance, and regulation of body salts are also harmed by low pH levels. Short-term pH depressions from spring snowmelt have caused overwintering of adult brook trout, resulting in increased mortalities (Mills, 1989). When the pH drops below 5.0, aluminum—a component of soils which is very toxic to fish—becomes more soluble and leaches into


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water (Shearer, 1992).

*Petition* at 29.

Coasters in the Salmon Trout River are also likely to be impacted from increased sedimentation due to huge traffic increases in and near the mine area. A background hydrogeology study states:

> Surface erosion, primarily from road runoff, is a well known existing condition potentially effecting stream quality on the Plains and downstream of the Plains. In order to roughly quantify sediment inputs from roads, sediment traps were established in the EBS that represent the range of traffic use, parent road material and road gradients that exist within the Study Area (Figure 18, Table 10).
>
> Traffic appears to be the strongest factor influencing erosion rates, which is consistent with other studies of road surface erosion associated with heavily logged watersheds (e.g., Reid and Dunne 1984). Two high-traffic monitoring locations (SED03 and SED08) on the Triple A Road yielded estimates of 256 and 515 tons per mile of road (tons/mi), respectively. Monitoring locations on the less frequently traveled Northwestern Road and secondary roads yielded estimates that were 1 to 2 orders of magnitude less (0.9-55 tons/mi) than the Triple A Road.

Mining Permit Application Vol. 2, Appendix B § 3.3.2.

As all of the ore will be transported from the site by truck, these roads will see a huge increase in traffic due to mining, and most of it will be heavy truck traffic. In addition to hauling ore, traffic will include a number of fuel trucks (electricity will be generated on site by diesel generators), aggregate trucks (cemented backfill will contained aggregate brought from off-site), other supply vehicles, and the cars and trucks of personnel. KEMC has not provided an estimate of its impacts, including increased traffic nor an assessment of the potential increased sedimentation in streams.

Once again quoting the petition for listing,

> Silt and sediment in rivers can threaten Coaster reproductive success. These substances can fill holding areas, rendering them unsuitable for adult migrating Coasters. In addition, silt and sediment can fill hollows, decreasing the amount of available protection for juvenile Coasters.
>
> Suspended and settling solids smother algal growth and kill rooted plants and moss. This changes substrate structure, which greatly decreases the biomass of benthic invertebrates on which the young Coasters feed.
>
> Coaster eggs may be killed due to lack of oxygenated water if silt is deposited in the interstices of the gravel substrate of the redd and diminishes the flow of water. Heavy concentrations of silt may cause problems with the respiration of fish, and fine silt has been known to cause alevin deaths by collecting on the gill membranes (Mills, 1989; Shearer 1992).


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Siltation can also affect water clarity and flow. Suspended solids reduce the amount of light penetration in the water column, which can affect the feeding and migration patterns of anadromous salmonids. Changes in flow patterns within the rivers due to bank erosion can affect the timing of migrations (Shearer, 1992).

*Petition* at 30-31.

Other pollutants that could affect coasters and other aquatic life are likely to be discharged to the Salmon Trout as well. The table below compares the approximate current level of selected pollutants in the Salmon Trout River to the proposed level to which groundwater would be allowed to degrade before any action is required (i.e., the groundwater standard). KEMC has provided no analysis of the level of pollutants that might remain in the groundwater at the point where it vents to the Salmon Trout River except for an analysis of mercury attenuation from the predicted levels in the TWIS discharge.10 The predicted TDRSA and CWB levels are included to give an indication of potential leakage into groundwater at the site.

| Pollutant | Salmon Trout baseflow level | Proposed ground water standard | TWIS discharge level | Composite TDRSA & CWB level |
|---|---|---|---|---|
| Boron | < 50 ug/l | 283 ug/l | 174 ug/l | 3671 ug/l |
| Cadmium | < 0.2 ug/l | 3 ug/l | 0.6 ug/l | 11 ug/l |
| Chloride | < 1.0 mg/l | 250 mg/l | 44 mg/l | 826 mg/l |
| Cobalt | < 10 ug/l | 23 ug/l | 9.3 ug/l | 652 ug/l |
| Copper | < 1.0 ug/l | 702 ug/l | 7.2 ug/l | 145 ug/l |
| Manganese | 13 ug/l | 474 ug/l | 2.4 ug/l | 885 ug/l |
| Mercury | 1.5 ng/l | 1000 ng/l | 2.1 ng/l | 4.1 ng/l |
| Nickel | < 1.0 ug/l | 58 ug/l | 4.9 ug/l | 33,403 ug/l |
| Selenium | < 2.0 ug/l | 25 ug/l | 1.3 ug/l | 26 ug/l |
| Sodium | 1.2 mg/l | 120 mg/l | 30 mg/l | 411 mg/l |
| Sulfate | < 5.0 mg/l | 250 mg/l | 1.7 mg/l | 167 mg/l |
| Zinc | < 10 ug/l | 1200 ug/l | 17 ug/l | 351 ug/l |

As you can see, KEMC has proposed a regulatory situation where it will be allowed to pollute

10 Note that the proposed mine plan would allow groundwater to become contaminated by mercury to much higher levels than assessed in this analysis.


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groundwater to a much lower quality than the quality of the Salmon Trout River. To reiterate, this groundwater will travel less than one mile before entering the Salmon Trout River. No analysis of natural attenuation has been done for any pollutant other than mercury.

Most of Michigan's water quality standards for dissolved metals are expressed in formulas that cannot be directly applied. *See* Mich. R. 323.1057. However, based on EPA water quality criteria and water quality standards in Michigan and other states, and on pollutant levels in the proposed discharge and/or water collecting in surface basins, we are particularly concerned about discharges to the Salmon Trout of cadmium, cobalt, copper, mercury, nickel, selenium, zinc, boron, chloride, and sulfate. Of these, cadmium, cobalt, mercury, and boron *are planned to be discharged through the TWIS* at levels that will violate numeric or narrative water quality standards and/or EPA criteria.

Michigan's antidegradation requirements for surface waters are set out in Michigan Rule 323.1098. The rule states that it "applies to any action or activity pursuant to section 324.3101 et seq. MCL that is anticipated to result in a new or increased loading of pollutants by any source to surface waters of the state and for which independent regulatory authority exists requiring compliance with water quality standards." Mich. R. § 323.1098(1).

According to a letter sent to KEMC from MDEQ, MDEQ interprets this regulation to apply to groundwater discharges that are anticipated to result in the new loading of pollutants to surface waters. *See* Letter from William Creal to Jon Cherry, September 14, 2005 (attached as Exhibit 6). However, MDEQ appears to be applying antidegradation requirements *only* to mercury discharges. KEMC has submitted an analysis to MDEQ that predicts that the mercury in the discharge will attenuate in the soil before it vents to the river.

While we disagree with KEMCs assumptions and conclusions regarding mercury, at this point we are primarily concerned that other pollutants that will degrade water quality in the Salmon Trout are being ignored. Under the proposed mining scenario it is very likely that some of these pollutants will be discharged to the Salmon Trout River. Federal oversight in this case is essential to protect the federal interests expressed in the Clean Water Act, the Safe Drinking water Act, and the Endangered Species Act.

The presence of federally listed endangered species and a species for which protection has been petitioned, increases the role of the federal government in this case. The Fish and Wildlife Service has been instrumental in regional attempts to preserve and restore coaster brook trout and Kirtland's warblers and has been concerned about their viability for a number of years. At the very least, we urge you to consult with the Fish and Wildlife Service before making a decision on whether to allow this project to go forward without an individual UIC permit.

Please let me know when you make a decision on whether to require an individual permit for KEMC's UIC activities. If you have any questions about this petition, I can be reached at 906/361-0520 or at halley@nwf.org.

Sincerely,

Michelle Halley

Michelle Halley



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Cc:
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## List of Exhibits

1. Groundwater Analyses Summary Table. Mining Permit Application Vol. 2, Appendix B-3 (Phase II Bedrock Hydrogeologic Investigation) Table 9.2.

2. Mine Drainage Water Characteristics. Groundwater Discharge Permit Application, Table 4-1.

3. Soil Analytical Results, Mining Permit Application Vol. 2, Appendix C (Surficial Geology), Table 3.

4. Mladenoff, David J., Theodore A. Sickley, Adrian P. Wydeven, and Robert G. Haight, "Regional Landscape Analysis and Prediction of Favorable Gray Wolf Habitat and Population Recovery in the Northern Great Lakes Region," http://www.timberwolfinformation.org/info/wolves/wolf.htm, accessed April 28, 2006.

5. Letter from William Creal, Michigan Dept. of Environmental Quality, to Jon Cherry, Kennecott Minerals Co., September 14, 2005.

Table 9.2. Groundwater Analyses Summary Table

| Sample Location | | 05EA-107 | 05EA-107 | 04EA-084 | 04EA-084 | 04EA-084 | 04EA-084 | 04EA-084 | Blind Duplicate | Blind Duplicate | Field Blank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Interval Depth (m along borehole) | | 18.20 to 34.90 | 97.52 to 114.22 | 249.05 to 302.08 | 249.05 to 302.08 | 249.05 to 302.08 | 249.05 to 302.08 | 249.05 to 302.08 | 04EA-084 | 04EA-084 | |
| Sample Date and Time | | 9/20/05 - 09:15 | 9/18/05 - 11:40 | 9/23/05 - 11:50 | 9/23/05 - 11:50 | 9/26/05 - 10:00 | 9/29/05 - 08:00 | 9/29/05 - 08:00 | 9/29/05 - 08:00 | 9/29/05 - 08:00 | 9/29/05 - 08:00 |
| Volume Purged Prior to Sampling | | 12 System Volumes Purged | 6 System Volumes Purged | 21 System Volumes Purged | 21 System Volumes Purged | 54 System Volumes Purged | 86 System Volumes Purged | 86 System Volumes Purged | 86 System Volumes Purged | 86 System Volumes Purged | |
| **Field Parameters** | | | | | | | | | | | |
| pH | s.u. | 7.57 | 7.52 | 8.25 | 8.25 | 8.42 | 8.1 | 8.1 | 8.1 | 8.1 | NA |
| Conductivity | µS/cm | 359 | 599 | 4980 | 4980 | 5980 | 5590 | 5590 | 5590 | 5590 | NA |
| Salinity | ‰ | 0.2 | 0.3 | 2.6 | 2.6 | 3.1 | 2.9 | 2.9 | 2.9 | 2.9 | NA |
| Total Dissolved Solids | mg/L | 168 | 287 | 2540 | 2540 | 3060 | 2840 | 2840 | 2840 | 2840 | NA |
| Turbidity | NTU | 18.5 | 56 | 5.92 | 5.92 | 1.35 | 2.35 | 2.35 | 2.35 | 2.35 | NA |
| Temperature (transducer) | °C | 9.4 | 12.3 | 9.4 | 9.4 | 10.4 | 8.5 | 8.5 | 8.5 | 8.5 | NA |
| **Metals by EPA 6000/7000** | Units | Dissolved Metals | Dissolved Metals | Dissolved Metals | Total Metals | NA | Dissolved Metals | Total Metals | Dissolved Metals | Total Metals | Dissolved Metals |
| Aluminum | ug/L | < 50 | < 50 | < 50 | < 50 | NA | < 50 | < 50 | < 50 | 67 | < 50 |
| Antimony | ug/L | < 5 | < 5 | < 5 | < 5 | NA | < 5 | < 5 | < 5 | < 5 | < 5 |
| Arsenic | ug/L | < 2 | < 2 | 23 | 3.7 | NA | 19 | 18 | 23 | 18 | < 2 |
| Barium | ug/L | < 20 | < 20 | 24 | 23 | NA | < 20 | < 100 | < 20 | < 100 | < 20 |
| Beryllium | ug/L | < 1 | < 1 | < 1 | < 1 | NA | < 1 | < 1 | < 1 | < 1 | < 1 |
| Boron | ug/L | 940 | 4100 | 5800 | 5700 | NA | 5900 | 5000 | 5800 | 5600 | 110 |
| Cadmium | ug/L | < 0.5 | < 0.5 | < 5 | < 5 | NA | < 5 | < 5 | < 5 | < 5 | < 0.5 |
| Calcium | mg/L | 5.9 | 3.1 | 83 | 79 | NA | 76 | 72 | 75 | 81 | < 0.5 |
| Chromium | ug/L | < 5 | < 5 | < 5 | < 5 | NA | < 5 | < 5 | < 5 | < 5 | < 5 |
| Cobalt | ug/L | < 10 | < 10 | < 10 | < 10 | NA | < 10 | < 10 | < 10 | < 10 | < 10 |
| Copper | ug/L | < 5 | < 5 | < 5 | < 5 | NA | < 5 | < 5 | < 5 | < 5 | < 5 |
| Iron | ug/L | 88 | 79 | 2100 | 2500 | NA | 1800 | 2600 | 1600 | 2900 | < 20 |
| Lead | ug/L | < 1 | < 1 | < 1 | < 1 | NA | < 1 | < 1 | < 1 | < 1 | < 1 |
| Lithium | ug/L | 13 | 16 | 140 | 130 | NA | 130 | 120 | 140 | 130 | < 8 |
| Magnesium | mg/L | 2.4 | 0.98 | 67 | 66 | NA | 61 | 61 | 61 | 65 | < 0.5 |
| Manganese | ug/L | 22 | < 20 | 85 | 81 | NA | 68 | 68 | 67 | 73 | < 20 |
| Molybdenum | ug/L | < 10 | < 10 | < 10 | < 10 | NA | < 10 | < 10 | < 10 | < 10 | < 10 |
| Mercury | ng/L | 0.81 | 3.51 | 0.44 | 0.6 | NA | 0.21 J | 0.66 J | 0.1U | 0.27 | 0.1 U |
| Nickel | ug/L | < 25 | < 25 | < 25 | < 25 | NA | < 25 | < 25 | < 25 | < 25 | < 25 |
| Selenium | ug/L | < 1 | < 1 | 21 | < 1 | NA | 17 | 3.6 | 21 | 7.7 | < 1 |
| Silver | ug/L | < 0.2 | < 0.2 | < 0.2 | < 0.2 | NA | 0.46 | < 1 | 1.1 | < 1 | 1.3 |
| Sodium | mg/L | 21 | 80 | 1100 | 1000 | NA | 970 | 1200 | 960 | 1200 | 0.77 |
| Strontium | ug/L | 170 | 91 | 5300 | 4700 | NA | 4800 | 4700 | 4700 | 5100 | < 50 |
| Zinc | ug/L | < 10 | 12 | 18 | 26 | NA | 19 | 39 | 19 | 40 | < 10 |
| Potassium | mg/L | 2.9 | 1.7 | 9.2 | 8.8 | NA | 9.2 | 8.5 | 9.3 | 9 | < 0.5 |
| **Physical/Chemical Parameters** | | | | | | | | | | | |
| Alkalinity, Bicarbonate | mg/L | 39 | 70 | 36 | NA | 37 | 37 | NA | 38 | NA | NA |
| Alkalinity, Carbonate | mg/L | < 2 | 28 | < 1 | NA | < 2 | 2.9 | NA | < 2 | NA | NA |
| Alkalinity, Total | mg/L | 83 | 98 | 34 | NA | 37 | 40 | NA | 38 | NA | NA |
| Chloride | mg/L | 1.2 | 97 | 1980 | NA | 2040 | 2010 | NA | 2020 | NA | NA |
| Fluoride | mg/L | 0.53 | 0.85 | 0.95 | NA | 0.99 | 1 | NA | 0.99 | NA | NA |
| Nitrogen, Ammonia | mg/L | 0.076 | 0.093 | 0.19 | NA | NA | 0.26 | NA | 0.27 | NA | NA |
| Nitrogen, Nitrate | mg/L | < 0.05 | < 0.05 | < 0.05 | NA | < 0.05 | < 0.05 | NA | < 0.05 | NA | NA |
| Phosphorus, Total | mg/L | < 0.01 | 0.033 | < 0.01 | NA | NA | 0.0148 | NA | 0.0136 | NA | NA |
| Residue, Dissolved | mg/L | 76 | 278 | 3990 | NA | 3980 | 3560 | NA | 3690 | NA | NA |
| Sulfate | mg/L | < 5 | < 5 | < 5 | NA | < 5 | < 5 | NA | < 5 | NA | NA |
| Sulfide | mg/L | < 1 | < 1 | < 1 | NA | NA | < 1 | NA | < 1 | NA | NA |
| Tritium | TU | < 0.8 | 0.6 | < 0.69 | NA | < 0.69 | < 0.71 | | < 0.83 | | NA |

Notes:
"U" Mercury sample results below the method detection limit (MDL) were reported at the MDL.
"J" Mercury result is an estimate. See notes in laboratory reports in Attachment B
NA Not Analyzed

Prepared By: MSL
Checked By: PU
Reviewed By: JSW

Exhibit 1

Exhibit 2

# Table 4-1
## Mine Drainage Water Characteristics

| Parameter | Upper Bedrock Groundwater (1) | Lower Bedrock Groundwater (2) | Composite Groundwater (3) | Incremental Change (4) | Composite Mine Drainage (5) |
|---|---|---|---|---|---|
| Percentage of Total Mine Groundwater Inflow | 55% | 45% | na | na | na |
| Aluminum, µg/l | 83 | 50 | 68 | 88 | 156 |
| Antimony, µg/l | 5.0 | 5 | 5.0 | 16 | 21 |
| Arsenic, µg/l | 2.0 | 19 | 10 | 17.0 | 27 |
| Barium, µg/l | 28 | 20 | 24 | 4.0 | 28 |
| Beryllium µg/l, | 1.0 | 1.0 | 1.0 | na | 1.0 |
| Boron, µg/l | 2,397 | 5,900 | 3,973 | 70 | 4,043 |
| Cadmium, µg/l | 0.5 | 5.0 | 2.5 | 10.0 | 13 |
| Calcium, µg/l | 15,983 | 76,000 | 42,991 | 4,000 | 46,991 |
| Chloride, µg/l | 41,367 | 2,000,000 | 922,752 | 1,580 | 924,332 |
| Chromium, µg/l | 5.0 | 5.0 | 5.0 | 4.5 | 10 |
| Cobalt, µg/l | 10.0 | 10.0 | 10.0 | 720 | 730 |
| Copper, µg/l | 5.0 | 5.0 | 5.0 | 150 | 155 |
| Fluoride, µg/l | 333 | 1,000 | 633 | 98 | 731 |
| Iron, µg/l | 67 | 1,800 | 847 | 6,400 | 7,247 |
| Lead, µg/l | 1.0 | 1.0 | 1.0 | 9.0 | 10 |
| Lithium, µg/l | 15 | 130 | 67 | 26 | 93 |
| Magnesium, µg/l | 2,897 | 61,000 | 29,043 | 5,000 | 34,043 |
| Manganese, µg/l | 20 | 68 | 42 | 950 | 992 |
| Mercury, µg/l | 0.00183 | 0.00021 | 0.00110 | 0.04 | 0.0411 |
| Molybdenum, µg/l | 10 | 10 | 10 | 13 | 23 |
| Nickel, µg/l | 26 | 25 | 25 | 36,400 | 36,425 |
| Nitrogen (Ammonia)[6], µg/l | 85 | 260 | 163 | 10,000 | 10,163 |
| Nitrogen (Nitrate), µg/l | 50 | 50 | 50 | 0 | 50 |
| Phosphorus, total | 22 | 15 | 18 | na | 18 |
| Potassium, µg/l | 4,350 | 9,200 | 6,533 | 1,000 | 7,533 |
| Selenium, µg/l | 1.0 | 17 | 8 | 20.0 | 28 |
| Silver, µg/l | 0.2 | 0.5 | 0.3 | 4.5 | 4.8 |
| Sodium, µg/l | 38,833 | 970,000 | 457,858 | 1,000 | 458,858 |
| Strontium, µg/l | 131 | 4,800 | 2,232 | 20 | 2,252 |
| Sulfate, µg/l | 10,317 | 5,000 | 7,924 | 110,000 | 117,924 |
| Thallium, µg/l | not analyzed | not analyzed | not analyzed | 8.0 | 8.0 |
| Vanadium, µg/l | not analyzed | not analyzed | not analyzed | 7.0 | 7.0 |
| Zinc, µg/l | 11 | 19 | 15 | 150 | 165 |

(1) Average value based on average of sample analysis from wells 04EA-054A, 04EA-054B, 04EA-054D, 04EA-054F (Golder 2005) and 05EA-107 (18-34 m, and 97-114 m in Appendix F-1)

(2) Based on sample analysis (04EA-084 86 purges, 249-302 m) documented in Appendix F-1

(3) Calculated as: (Upper Bedrock Groundwater Conc.)(Upper Bedrock % of Inflow) + (Lower Bedrock Groundwater Conc.)(Lower Bedrock % of Inflow). Total mine inflow assumed to be 250 gpm.

(4) Incremental change in concentration of indicated groundwater chemical constituents due to contact with mine workings. (Appendix F-2)

(5) Composite groundwater concentration plus incremental change (Appendix G).

(6) Incremental change is estimated increase due to blasting residuals.

na = not applicable

Prepared by: JJF1
Checked by: SVD1

Exhibit 3

**TABLE 3**
**SOIL ANALYTICAL RESULTS**
**PROPSOSED KENNECOTT EAGLE MINE SITE**

| SAMPLE | pH | Ag | Al | As | Ba | Be | Bi | Ca | Cd | Ce | Co | Cr | Cs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCATION | S.U. | ppm | % | ppm | ppm | ppm | ppm | % | ppm | ppm | ppm | ppm | ppm |
| ABL-021 | 5.2 | 0.06 | 4.14 | 4.5 | 530 | 1.11 | 0.21 | 0.46 | 0.12 | 60.0 | 6.1 | 56 | 1.40 |
| ABL-022 | 5.1 | 0.04 | 3.93 | 3.1 | 520 | 0.79 | 0.11 | 0.27 | 0.07 | 32.7 | 3.3 | 26 | 1.48 |
| ABL-023 | 5.2 | 0.04 | 4.47 | 3.8 | 510 | 0.84 | 0.17 | 0.31 | 0.08 | 53.1 | 4.7 | 38 | 1.60 |
| ABL-024 | 5.1 | 0.05 | 4.55 | 4.1 | 530 | 1.04 | 0.17 | 0.35 | 0.09 | 53.3 | 6.7 | 44 | 1.72 |
| ABL-025 | 5.4 | 0.07 | 4.19 | 5.2 | 480 | 0.92 | 0.20 | 0.33 | 0.10 | 59.5 | 7.0 | 53 | 1.58 |
| ABL-026 | 6.6 | 0.05 | 4.95 | 4.9 | 570 | 0.56 | 0.13 | 0.34 | 0.07 | 30.6 | 4.1 | 44 | 1.22 |
| ABL-027 | 5.2 | 0.06 | 4.07 | 4.2 | 520 | 0.56 | 0.14 | 0.35 | 0.08 | 37.9 | 5.2 | 57 | 0.91 |
| ABL-028 | 5.4 | 0.08 | 4.51 | 9.0 | 510 | 0.62 | 0.18 | 0.26 | 0.09 | 34.5 | 4.1 | 35 | 1.44 |
| ABL-029 | 5.4 | 0.10 | 4.73 | 4.1 | 570 | 0.68 | 0.12 | 0.34 | 0.09 | 44.6 | 5.1 | 30 | 1.23 |
| ABL-030 | 4.8 | 0.16 | 5.35 | 5.3 | 510 | 1.04 | 0.19 | 0.51 | 0.11 | 49.5 | 9.1 | 52 | 1.74 |
| ABL-036 | 5.1 | 0.07 | 4.12 | 3.9 | 570 | 0.53 | 0.12 | 0.33 | 0.06 | 28.3 | 4.2 | 32 | 0.94 |
| ABL-037 | 5.0 | 0.08 | 4.86 | 4.4 | 560 | 0.85 | 0.13 | 0.44 | 0.10 | 42.3 | 6.3 | 45 | 1.38 |
| ABL-038 | 4.6 | 0.04 | 4.02 | 3.1 | 500 | 0.63 | 0.08 | 0.45 | 0.07 | 33.4 | 4.3 | 39 | 0.93 |
| ABL-039 | 4.9 | 0.14 | 4.80 | 4.9 | 510 | 0.88 | 0.18 | 0.52 | 0.12 | 55.0 | 8.3 | 55 | 1.57 |
| ABL-040 | 4.2 | 0.29 | 5.19 | 8.6 | 440 | 0.87 | 0.19 | 0.46 | 0.27 | 40.0 | 9.6 | 46 | 1.50 |
| ABL-046 | 5.3 | 0.05 | 4.50 | 5.2 | 490 | 1.14 | 0.18 | 0.55 | 0.15 | 53.4 | 8.5 | 52 | 1.48 |
| ABL-048 | 4.6 | 0.08 | 4.54 | 11.3 | 500 | 0.83 | 0.19 | 0.42 | 0.12 | 47.4 | 6.1 | 48 | 1.75 |
| ABL-049 | 4.8 | 0.07 | 4.12 | 4.2 | 470 | 0.86 | 0.16 | 0.43 | 0.12 | 52.3 | 6.1 | 52 | 1.60 |
| DPR-021 | 4.9 | 0.05 | 3.88 | 3.1 | 580 | 0.54 | 0.09 | 0.27 | 0.07 | 30.2 | 4.1 | 24 | 1.16 |
| DPR-022 | 5.3 | 0.06 | 3.63 | 3.3 | 550 | 0.59 | 0.09 | 0.27 | 0.06 | 34.8 | 4.4 | 22 | 1.08 |
| DPR-023 | 5.2 | 0.09 | 3.15 | 3.5 | 560 | 0.55 | 0.11 | 0.36 | 0.08 | 42.4 | 3.7 | 24 | 0.80 |
| DPR-024 | 5.2 | 0.06 | 3.70 | 3.2 | 550 | 0.66 | 0.11 | 0.36 | 0.07 | 43.6 | 5.3 | 30 | 0.89 |
| DPR-025 | 5.3 | 0.05 | 4.05 | 2.9 | 540 | 0.70 | 0.10 | 0.44 | 0.06 | 32.4 | 5.1 | 27 | 0.96 |
| DPR-026 | 5.4 | 0.05 | 3.75 | 2.7 | 590 | 0.56 | 0.06 | 0.27 | 0.05 | 35.0 | 4.0 | 18 | 0.98 |
| DPR-027 | 5.1 | 0.06 | 4.68 | 3.8 | 510 | 0.77 | 0.11 | 0.51 | 0.07 | 44.0 | 5.6 | 33 | 0.99 |
| DPR-028 | 5.3 | 0.05 | 3.85 | 3.0 | 540 | 0.62 | 0.11 | 0.39 | 0.07 | 34.5 | 5.7 | 33 | 0.97 |
| BLANK | NM | <.02 | <.01 | <.2 | <10 | <.05 | <.01 | <.01 | <.02 | <.01 | <.1 | <1 | <.05 |
| | **Michigan Default Background (ppm) (Note 3)** | | | | | | | | | | | | |
| | - | 1.0 | 0.69 | 5.8 | 75 | - | - | - | 1.2 | - | 6.8 | 18 | - |
| | **Statistical Analyses** | | | | | | | | | | | | |
| **Mean** | 5.1 | 0.08 | 4.30 | 4.6 | 527 | 0.76 | 0.14 | 0.38 | 0.09 | 42.5 | 5.6 | 39 | 1.28 |
| **Std. Dev.** | 0.4 | 0.05 | 0.52 | 2.0 | 37 | 0.19 | 0.04 | 0.09 | 0.04 | 9.6 | 1.7 | 12 | 0.31 |
| **Maximum** | 6.6 | 0.29 | 5.35 | 11.3 | 590 | 1.14 | 0.21 | 0.55 | 0.27 | 60.0 | 9.6 | 57 | 1.75 |
| **Minimum** | 4.2 | 0.04 | 3.15 | 2.7 | 440 | 0.53 | 0.06 | 0.26 | 0.05 | 28.3 | 3.3 | 18 | 0.80 |

Notes:
1. Samples collected by Golder Associates Inc., June 15 - 17, 2004.
2. Samples analyzed by ALS Chemex, Thunder Bay, Ontario.
3. Michigan Act 451, Part 201, Rule 746 Table 2 (Statewide Default Background Concentrations)
4. Element Abbreviations:

| | | | | | |
|---|---|---|---|---|---|
| Ag: | Silver | Be: | Beryllium | Ce: | Cerium |
| Al: | Aluminum | Bi: | Bismuth | Co: | Cobalt |
| As: | Arsenic | Ca: | Calcium | Cr: | Chromium |
| Ba: | Barium | Cd: | Cadmium | Cs: | Cesium |

TABLE 3
SOIL ANALYTICAL RESULTS
PROPSOSED KENNECOTT EAGLE MINE SITE

| SAMPLE | Cu | Fe | Ga | Ge | Hf | Hg | In | K | La | Li | Mg | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCATION | ppm | % | ppm | ppm | ppm | ppm | ppm | % | ppm | ppm | % | ppm |
| ABL-021 | 8.7 | 5.84 | 12.80 | 0.19 | 5.1 | 0.02 | 0.034 | 2.27 | 33.0 | 7.9 | 0.25 | 601 |
| ABL-022 | 5.6 | 2.39 | 10.00 | 0.13 | 3.4 | 0.02 | 0.021 | 2.39 | 15.5 | 9.0 | 0.17 | 231 |
| ABL-023 | 6.9 | 3.90 | 11.85 | 0.17 | 5.4 | 0.03 | 0.030 | 2.28 | 24.9 | 11.3 | 0.23 | 376 |
| ABL-024 | 7.9 | 4.28 | 11.75 | 0.16 | 5.2 | 0.02 | 0.035 | 2.39 | 26.1 | 11.6 | 0.26 | 480 |
| ABL-025 | 9.5 | 5.81 | 12.05 | 0.20 | 5.7 | 0.03 | 0.038 | 2.25 | 27.6 | 10.8 | 0.25 | 560 |
| ABL-026 | 9.0 | 3.84 | 10.70 | 0.11 | 4.2 | 0.07 | 0.022 | 2.39 | 19.8 | 7.6 | 0.24 | 357 |
| ABL-027 | 8.6 | 6.76 | 7.71 | 0.13 | 3.8 | 0.03 | 0.021 | 2.38 | 18.8 | 5.7 | 0.26 | 676 |
| ABL-028 | 9.5 | 3.69 | 12.65 | 0.14 | 5.1 | 0.08 | 0.029 | 2.42 | 19.9 | 9.5 | 0.21 | 447 |
| ABL-029 | 10.7 | 3.27 | 10.90 | 0.14 | 5.0 | 0.06 | 0.022 | 2.59 | 24.5 | 9.6 | 0.26 | 341 |
| ABL-030 | 13.7 | 4.95 | 13.45 | 0.17 | 4.9 | 0.07 | 0.039 | 2.23 | 25.5 | 15.8 | 0.38 | 476 |
| ABL-036 | 6.8 | 3.44 | 7.61 | 0.10 | 2.9 | 0.04 | 0.019 | 2.51 | 18.0 | 6.2 | 0.23 | 367 |
| ABL-037 | 13.5 | 4.01 | 11.45 | 0.13 | 5.2 | 0.05 | 0.025 | 2.54 | 23.0 | 11.8 | 0.29 | 387 |
| ABL-038 | 6.0 | 3.81 | 7.59 | 0.10 | 3.3 | 0.03 | 0.014 | 2.25 | 15.8 | 5.5 | 0.26 | 431 |
| ABL-039 | 12.9 | 4.99 | 13.10 | 0.16 | 4.7 | 0.05 | 0.032 | 2.18 | 32.9 | 13.4 | 0.34 | 476 |
| ABL-040 | 18.0 | 4.79 | 12.80 | 0.14 | 4.5 | 0.15 | 0.038 | 1.79 | 23.8 | 14.5 | 0.32 | 772 |
| ABL-046 | 11.3 | 5.42 | 11.80 | 0.18 | 4.0 | 0.03 | 0.038 | 2.17 | 27.3 | 11.4 | 0.36 | 578 |
| ABL-048 | 10.2 | 4.83 | 13.05 | 0.18 | 4.7 | 0.07 | 0.032 | 2.23 | 26.1 | 11.0 | 0.29 | 494 |
| ABL-049 | 9.0 | 4.69 | 12.05 | 0.19 | 3.6 | 0.05 | 0.027 | 2.03 | 26.2 | 10.2 | 0.25 | 488 |
| DPR-021 | 7.1 | 2.35 | 8.68 | 0.10 | 3.3 | 0.03 | 0.015 | 2.65 | 16.0 | 7.3 | 0.19 | 334 |
| DPR-022 | 7.9 | 2.54 | 8.16 | 0.11 | 5.1 | 0.03 | 0.016 | 2.53 | 19.6 | 7.3 | 0.20 | 318 |
| DPR-023 | 7.1 | 2.58 | 6.80 | 0.12 | 3.6 | 0.01 | 0.016 | 2.61 | 19.0 | 4.9 | 0.21 | 383 |
| DPR-024 | 8.6 | 3.46 | 7.77 | 0.13 | 4.6 | 0.01 | 0.016 | 2.56 | 21.4 | 6.0 | 0.24 | 407 |
| DPR-025 | 7.6 | 2.98 | 8.79 | 0.11 | 3.3 | 0.03 | 0.015 | 2.37 | 17.0 | 7.1 | 0.24 | 317 |
| DPR-026 | 7.1 | 1.78 | 7.33 | 0.10 | 2.9 | 0.03 | 0.012 | 2.72 | 15.0 | 6.5 | 0.19 | 253 |
| DPR-027 | 11.9 | 3.46 | 9.53 | 0.15 | 5.2 | 0.03 | 0.019 | 2.20 | 21.9 | 8.4 | 0.28 | 385 |
| DPR-028 | 6.5 | 3.27 | 8.69 | 0.12 | 3.5 | 0.01 | 0.016 | 2.41 | 18.6 | 6.8 | 0.24 | 374 |
| BLANK | <.2 | <.01 | 0.07 | <.05 | <.1 | NM | <.005 | <.01 | <.5 | <.2 | <.01 | <5 |
| | Michigan Default Background (ppm) (Note 3) | | | | | | | | | | | |
| | 32 | 0.12 | - | - | - | 0.13 | - | - | - | 9.8 | - | 440 |
| | Statistical Analyses | | | | | | | | | | | |
| Mean | 9.3 | 3.97 | 10.35 | 0.14 | 4.3 | 0.04 | 0.025 | 2.36 | 22.2 | 9.1 | 0.26 | 435 |
| Std. Dev. | 2.9 | 1.23 | 2.19 | 0.03 | 0.9 | 0.03 | 0.009 | 0.21 | 5.0 | 2.9 | 0.05 | 126 |
| Maximum | 18.0 | 6.76 | 13.45 | 0.20 | 5.7 | 0.15 | 0.039 | 2.72 | 33.0 | 15.8 | 0.38 | 772 |
| Minimum | 5.6 | 1.78 | 6.80 | 0.10 | 2.9 | 0.01 | 0.012 | 1.79 | 15.0 | 4.9 | 0.17 | 231 |

Notes: 1. Samples collected by Golder Associates Inc., June 15 - 17, 2004.
2. Samples analyzed by ALS Chemex, Thunder Bay, Ontario.
3. Michigan Act 451, Part 201, Rule 746 Table 2 (Statewide Default Background Concentrations)
4. Element Abbreviations:

| | | | | | |
|---|---|---|---|---|---|
| Cu: | Copper | Hf: | Hafnium | La: | Lanthanum |
| Fe: | Iron | Hg: | Mercury | Li: | Lithium |
| Ga: | Gallium | In: | Indium | Mg: | Magnesium |
| Ge: | Germanium | K: | Potassium | Mn: | Manganese |

**TABLE 3**
**SOIL ANALYTICAL RESULTS**
**PROPSOSED KENNECOTT EAGLE MINE SITE**

| SAMPLE | Mo | Na | Nb | Ni | P | Pb | Rb | Re | S | Sb | Se | Sn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOCATION | ppm | % | ppm | ppm | ppm | ppm | ppm | ppm | % | ppm | ppm | ppm |
| ABL-021 | 0.91 | 0.73 | 12.0 | 13.0 | 220 | 17.6 | 79.7 | <0.002 | 0.01 | 1.20 | 1 | 2.3 |
| ABL-022 | 0.59 | 0.44 | 6.2 | 8.6 | 420 | 13.3 | 82.1 | <0.002 | 0.01 | 0.60 | 1 | 1.3 |
| ABL-023 | 0.80 | 0.41 | 8.6 | 8.9 | 410 | 16.6 | 81.3 | <0.002 | 0.02 | 0.89 | 1 | 1.7 |
| ABL-024 | 0.88 | 0.46 | 10.6 | 12.6 | 600 | 16.8 | 85.0 | <0.002 | 0.02 | 1.00 | 1 | 1.8 |
| ABL-025 | 0.97 | 0.40 | 11.2 | 13.1 | 660 | 18.2 | 81.3 | <0.002 | 0.01 | 1.18 | 1 | 2.1 |
| ABL-026 | 0.76 | 0.54 | 8.1 | 10.0 | 500 | 14.0 | 65.7 | <0.002 | 0.02 | 0.82 | 2 | 1.3 |
| ABL-027 | 0.63 | 0.46 | 8.5 | 8.6 | 460 | 13.4 | 59.3 | <0.002 | 0.01 | 0.89 | 2 | 1.6 |
| ABL-028 | 0.99 | 0.39 | 8.6 | 7.8 | 740 | 18.3 | 75.6 | <0.002 | 0.02 | 0.86 | 2 | 1.6 |
| ABL-029 | 0.72 | 0.49 | 8.4 | 10.8 | 550 | 13.8 | 70.6 | <0.002 | 0.03 | 0.62 | 2 | 1.3 |
| ABL-030 | 0.94 | 0.62 | 10 | 19.3 | 560 | 16.6 | 78.2 | <0.002 | 0.03 | 0.93 | 1 | 2.0 |
| ABL-036 | 0.63 | 0.52 | 7.7 | 7.7 | 370 | 11.8 | 56.6 | <0.002 | 0.01 | 0.74 | 1 | 1.4 |
| ABL-037 | 0.77 | 0.62 | 8.7 | 12.2 | 460 | 15.3 | 79.1 | <0.002 | 0.01 | 0.73 | 2 | 1.4 |
| ABL-038 | 0.40 | 0.60 | 5.8 | 7.8 | 420 | 11.3 | 58.1 | <0.002 | 0.01 | 0.55 | 1 | 1.1 |
| ABL-039 | 0.83 | 0.67 | 11.7 | 14.7 | 490 | 17.3 | 74.8 | <0.002 | 0.01 | 0.86 | 2 | 1.7 |
| ABL-040 | 1.16 | 0.55 | 9.9 | 16.5 | 960 | 20.8 | 59.8 | <0.002 | 0.03 | 0.92 | 3 | 1.8 |
| ABL-046 | 0.78 | 0.63 | 9.9 | 18.4 | 600 | 16.6 | 74.4 | <0.002 | 0.01 | 1.12 | 1 | 2.0 |
| ABL-048 | 0.82 | 0.54 | 9.3 | 13.2 | 500 | 16.9 | 78.1 | <0.002 | 0.01 | 0.96 | 1 | 1.8 |
| ABL-049 | 0.74 | 0.56 | 8.1 | 10.9 | 470 | 15.0 | 75.7 | <0.002 | 0.02 | 0.83 | 1 | 1.6 |
| DPR-021 | 0.45 | 0.41 | 6.5 | 7.2 | 360 | 12.7 | 80.3 | <0.002 | 0.01 | 0.57 | 1 | 1.1 |
| DPR-022 | 0.52 | 0.41 | 6.8 | 8.4 | 240 | 12.4 | 76.8 | <0.002 | 0.01 | 0.61 | 1 | 1.1 |
| DPR-023 | 0.36 | 0.39 | 7.4 | 6.1 | 360 | 12.2 | 77.0 | <0.002 | 0.01 | 0.89 | 1 | 1.1 |
| DPR-024 | 0.50 | 0.47 | 7.7 | 8.9 | 210 | 13.1 | 73.3 | <0.002 | 0.01 | 0.69 | 1 | 1.3 |
| DPR-025 | 0.41 | 0.66 | 6.2 | 9.0 | 280 | 12.9 | 70.3 | <0.002 | 0.01 | 0.57 | 1 | 1.1 |
| DPR-026 | 0.34 | 0.41 | 5.4 | 7.0 | 210 | 11.8 | 80.8 | <0.002 | 0.01 | 0.51 | 1 | 0.9 |
| DPR-027 | 0.57 | 0.68 | 7.4 | 10.2 | 420 | 14.7 | 62.4 | <0.002 | 0.01 | 0.57 | 2 | 1.2 |
| DPR-028 | 0.43 | 0.53 | 7.0 | 16.0 | 430 | 12.7 | 70.7 | <0.002 | 0.01 | 0.61 | 1 | 1.2 |
| BLANK | <.05 | <.01 | <.1 | <.2 | <10 | <.5 | 0.3 | <.002 | <.01 | <.05 | 1 | <.2 |
| | **Michigan Default Background (ppm) (Note 3)** | | | | | | | | | | | |
| | - | - | - | 20.0 | - | 21 | - | - | - | - | 0.41 | - |
| | **Statistical Analyses** | | | | | | | | | | | |
| **Mean** | 0.69 | 0.52 | 8.4 | 11.0 | 458 | 14.9 | 73.3 | <0.002 | 0.01 | 0.80 | 1 | 1.5 |
| **Std. Dev.** | 0.22 | 0.10 | 1.8 | 3.6 | 171 | 2.5 | 8.2 | <0.002 | 0.01 | 0.20 | 1 | 0.4 |
| **Maximum** | 1.16 | 0.73 | 12.0 | 19.3 | 960 | 20.8 | 85.0 | <0.002 | 0.03 | 1.20 | 3 | 2.3 |
| **Minimum** | 0.34 | 0.39 | 5.4 | 6.1 | 210 | 11.3 | 56.6 | <0.002 | 0.01 | 0.51 | 1 | 0.9 |

Notes: 1. Samples collected by Golder Associates Inc., June 15 - 17, 2004.
2. Samples analyzed by ALS Chemex, Thunder Bay, Ontario.
3. Michigan Act 451, Part 201, Rule 746 Table 2 (Statewide Default Background Concentrations)
4. Element Abbreviations:

| | | | | | |
|---|---|---|---|---|---|
| Mo: | Molybdenum | P: | Phosphorus | S: | Sulfur |
| Na: | Sodium | Pb: | Lead | Sb: | Antimony |
| Nb: | Niobium | Rb: | Rubidium | Se: | Selenium |
| Ni: | Nickel | Re: | Rhenium | Sn: | Tin |

**TABLE 3**
**SOIL ANALYTICAL RESULTS**
**PROPSOSED KENNECOTT EAGLE MINE SITE**

| SAMPLE LOCATION | Sr ppm | Ta ppm | Te ppm | Th ppm | Ti % | Tl ppm | U ppm | V ppm | W ppm | Y ppm | Zn ppm | Zr ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ABL-021 | 122 | 0.95 | <0.05 | 12.2 | 0.69 | 0.46 | 2.6 | 160 | 1.3 | 17.7 | 42 | 160 |
| ABL-022 | 88 | 0.49 | <0.05 | 6.5 | 0.31 | 0.46 | 1.4 | 56 | 0.6 | 12.9 | 29 | 115 |
| ABL-023 | 82 | 0.73 | <0.05 | 9.1 | 0.50 | 0.45 | 2.2 | 98 | 0.9 | 16.2 | 31 | 178 |
| ABL-024 | 89 | 0.85 | 0.05 | 10.1 | 0.59 | 0.47 | 2.2 | 110 | 0.9 | 16.8 | 33 | 169 |
| ABL-025 | 84 | 0.78 | <0.05 | 9.8 | 0.66 | 0.46 | 2.4 | 149 | 1.1 | 21.0 | 41 | 188 |
| ABL-026 | 83 | 0.49 | <0.05 | 5.8 | 0.47 | 0.35 | 1.6 | 97 | 0.6 | 15.1 | 36 | 167 |
| ABL-027 | 71 | 0.57 | <0.05 | 6.2 | 0.79 | 0.31 | 1.7 | 181 | 0.7 | 18.7 | 45 | 215 |
| ABL-028 | 73 | 0.60 | 0.05 | 7.8 | 0.46 | 0.44 | 2.1 | 86 | 0.8 | 14.1 | 36 | 157 |
| ABL-029 | 87 | 0.55 | <0.05 | 8.6 | 0.47 | 0.38 | 1.8 | 80 | 0.6 | 13.6 | 32 | 178 |
| ABL-030 | 107 | 0.78 | <0.05 | 9.6 | 0.54 | 0.43 | 2.2 | 124 | 0.9 | 17.6 | 58 | 159 |
| ABL-036 | 80 | 0.48 | <0.05 | 5.0 | 0.45 | 0.30 | 1.4 | 84 | 0.7 | 14.1 | 29 | 116 |
| ABL-037 | 111 | 0.54 | <0.05 | 8.6 | 0.44 | 0.46 | 2.0 | 99 | 0.7 | 13.1 | 36 | 211 |
| ABL-038 | 89 | 0.47 | <0.05 | 13.5 | 0.43 | 0.27 | 1.3 | 88 | 0.4 | 11.5 | 44 | 159 |
| ABL-039 | 121 | 2.72 | <0.05 | 10.5 | 0.53 | 0.45 | 2.1 | 126 | 0.9 | 14.8 | 47 | 168 |
| ABL-040 | 101 | 0.61 | 0.05 | 9.2 | 0.52 | 0.40 | 2.0 | 118 | 0.9 | 13.4 | 68 | 182 |
| ABL-046 | 115 | 0.77 | <0.05 | 9.1 | 0.59 | 0.41 | 2.1 | 135 | 1.1 | 21.6 | 42 | 119 |
| ABL-048 | 100 | 0.71 | <0.05 | 10.6 | 0.57 | 0.45 | 2.0 | 125 | 0.8 | 16.5 | 41 | 146 |
| ABL-049 | 105 | 0.63 | <0.05 | 9.2 | 0.47 | 0.42 | 1.8 | 117 | 1.7 | 16.0 | 35 | 116 |
| DPR-021 | 75 | 0.44 | <0.05 | 5.1 | 0.35 | 0.46 | 1.4 | 56 | 0.6 | 10.5 | 32 | 132 |
| DPR-022 | 77 | 0.41 | <0.05 | 6.1 | 0.41 | 0.43 | 1.6 | 63 | 0.5 | 10.9 | 23 | 191 |
| DPR-023 | 79 | 0.47 | <0.05 | 5.4 | 0.46 | 0.40 | 1.4 | 62 | 0.7 | 13.0 | 16 | 143 |
| DPR-024 | 82 | 0.54 | <0.05 | 6.5 | 0.50 | 0.37 | 1.8 | 84 | 0.6 | 14.4 | 23 | 178 |
| DPR-025 | 113 | 0.44 | <0.05 | 4.8 | 0.36 | 0.37 | 1.3 | 69 | 0.5 | 9.5 | 21 | 126 |
| DPR-026 | 74 | 0.35 | <0.05 | 4.3 | 0.28 | 0.44 | 1.3 | 40 | 0.5 | 13.1 | 18 | 113 |
| DPR-027 | 115 | 0.51 | <0.05 | 9.2 | 0.42 | 0.34 | 1.9 | 80 | 0.5 | 13.2 | 29 | 185 |
| DPR-028 | 92 | 0.47 | <0.05 | 5.5 | 0.39 | 0.37 | 1.4 | 76 | 0.6 | 11.7 | 25 | 131 |
| BLANK | <.2 | <.05 | <.05 | <.2 | <.005 | <.02 | <.1 | <1 | <.1 | <.1 | <2 | <.5 |
| | Michigan Default Background (ppm) (Note 3) | | | | | | | | | | | |
| | - | - | - | - | - | - | - | - | - | - | 47 | - |
| | Statistical Analyses | | | | | | | | | | | |
| Mean | 93 | 0.67 | 0.05 | 8.0 | 0.48 | 0.41 | 1.8 | 99 | 0.8 | 14.7 | 35 | 158 |
| Std. Dev. | 16 | 0.44 | 0 | 2.4 | 0.12 | 0.06 | 0.4 | 35 | 0.3 | 3.0 | 12 | 30 |
| Maximum | 122 | 2.72 | 0.05 | 13.5 | 0.79 | 0.47 | 2.6 | 181 | 1.7 | 21.6 | 68 | 215 |
| Minimum | 71 | 0.35 | 0.05 | 4.3 | 0.28 | 0.27 | 1.3 | 40 | 0.4 | 9.5 | 16 | 113 |

Notes: 1. Samples collected by Golder Associates Inc., June 15 - 17, 2004.
2. Samples analyzed by ALS Chemex, Thunder Bay, Ontario.
3. Michigan Act 451, Part 201, Rule 746 Table 2 (Statewide Default Background Concentrations)
4. Element Abbreviations:

| | | | | | |
|---|---|---|---|---|---|
| Sr: | Strontium | Ti: | Titanium | W: | Tungsten |
| Ta: | Tantalum | Tl: | Thallium | Y: | Yttrium |
| Te: | Tellurium | U: | Uranium | Zn: | Zinc |
| Th: | Thorium | V: | Vanadium | Zr: | Zirconium |

# Regional Landscape Analysis and Prediction of Favorable Gray Wolf Habitat and Population Recovery in the Northern Great Lakes Region

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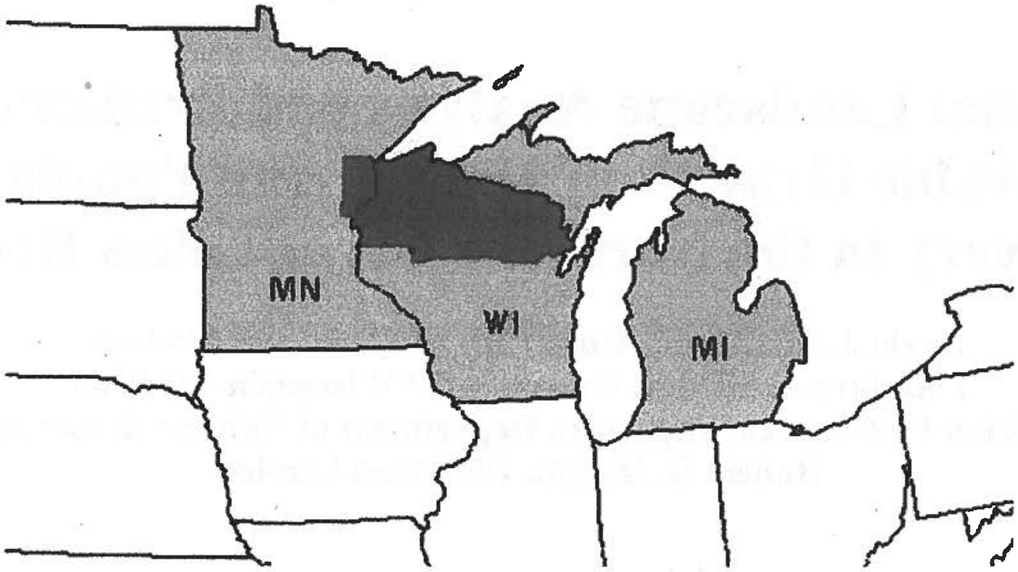
## INTRODUCTION

### BACKGROUND

For 15 years, the endangered eastern timber wolf has been slowly recolonizing northern Wisconsin and, more recently, upper Michigan, largely by dispersing from Minnesota (where it is listed as threatened). We used geographic information systems (GIS) technology, spatial radiocollar data from recolonizing wolves in northern Wisconsin and adjacent Minnesota, and a statistical logistic regression technique to assess the importance of landscape scale factors in defining favorable habitat.

Our goals were to: (1) create a useful model that would allow wildlife biologists and natural resource managers to predict where future wolf recolonization activity might occur in the upper Great Lakes region, and (2) estimate the range of wolf populations that the region might support, based on the availability of favorable habitat and the availability of prey.

Exhibit 4




Northern Great Lake states (gray) and study area (magenta)

**METHODS**

(1) Wolf radiocollar locations were digitized from maps provided by the Wisconsin Department of Natural Resources. Locations were grouped by pack, and wolf pack home ranges were generated. For the statistical analysis, an equal number of randomly distributed non-wolf pack areas were created.

(2) Several spatial data bases thought to influence the distribution of wolf packs were assembled in the GIS software program Arc/Info. These data bases include land cover type, land ownership category, road density, human population density, and deer (prey) density.

(3) Pack areas and non-pack areas were intersected with the spatial data bases. A value for each of the data base variables was calculated for each pack and non-pack area.

(4) The variables were entered into a logistic regression model to determine which variables were most strongly associated with the presence of wolf packs.

(5) The results of the logistic regression model were applied across the northern Great Lakes region to show the distribution of favorable wolf habitat.

(6) The amount of favorable habitat and the density of prey were used to estimate the potential timber wolf population for the region.

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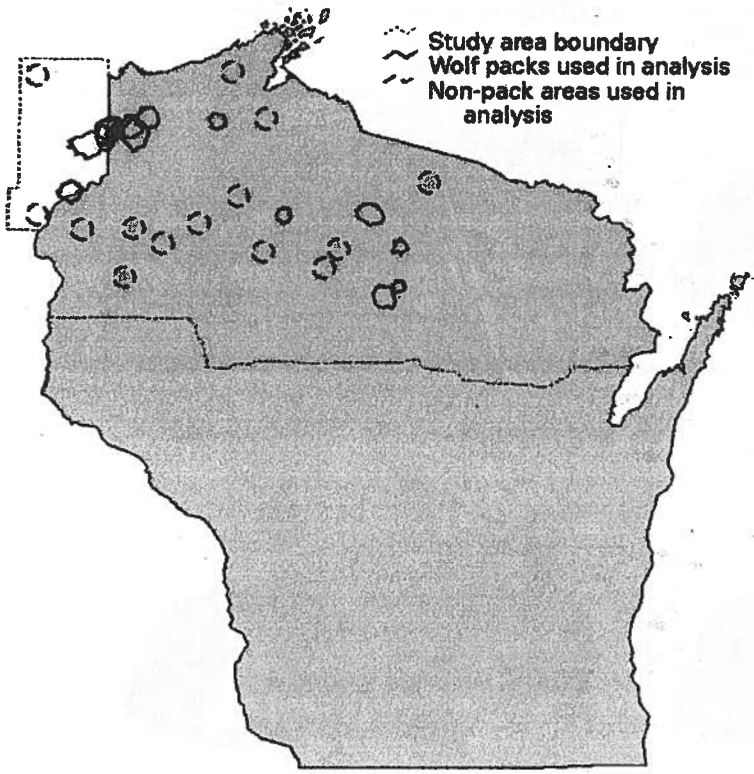
# MODEL BUILDING

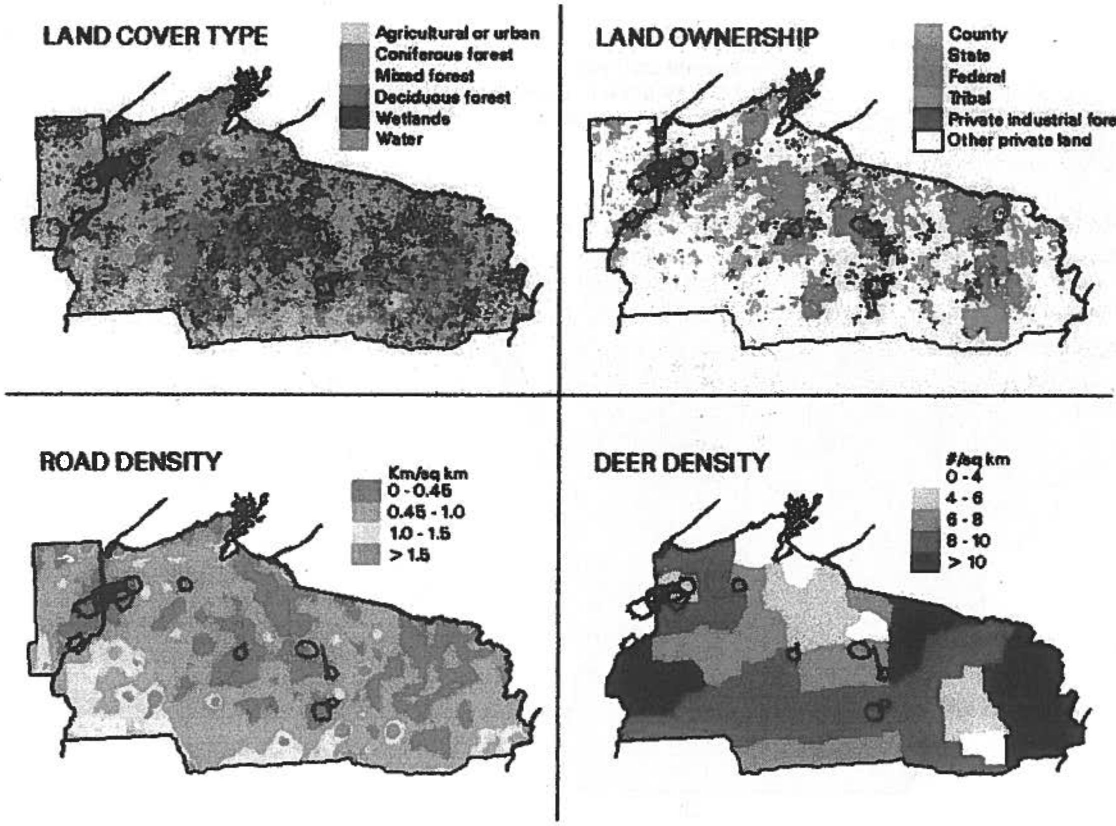
**WISCONSIN WOLF PACKS**




In 1974 the eastern timber wolf was given protection under Federal Endangered Species Act of 1973. At that time, Minnesota had the only breeding population of timber wolves in the lower 48 states. Since then, the wolf population of Minnesota has grown from roughly 500 to nearly 2000 animals. This growing population in Minnesota is thought to be the source of timber wolves sited in neighboring Wisconsin in the late 1970s. Wisconsin currently supports approximately 100 wolves. Upper Michigan has a population of approximately 115 wolves. Wisconsin wolves have been captured, radiocollared, and tracked by the Department of Natural Resources since 1979. We used the radiocollar points and a harmonic mean method to determine the home range of each wolf pack. Several wolf packs in Wisconsin contain no collared wolves, or contain wolves that were collared for a very short time. These packs were not used in the statistical analysis, but were used to assess the results of the model.

## HABITAT VARIABLES

- ***Land cover*** data were taken from the US Geological Survey 1:250,000 Land Use/Land Cover data base.
- ***Major land ownership*** data were digitized from 1:500,000 Land Resources Analysis Program maps created in 1974 by the Wisconsin Planning Agency.
- ***Road density*** data were created from a roads coverage extracted from the US Census Bureau TIGER/line files. These roads include highways, other paved roads, and improved unsurfaced roads passable by auto, but exclude unimproved forest roads and trails.
- ***Deer density*** data were calculated from Wisconsin Department of Natural Resources deer management unit maps and annual deer population estimates.
- ***Human population density*** (not shown below) was calculated from US Census Bureau data.



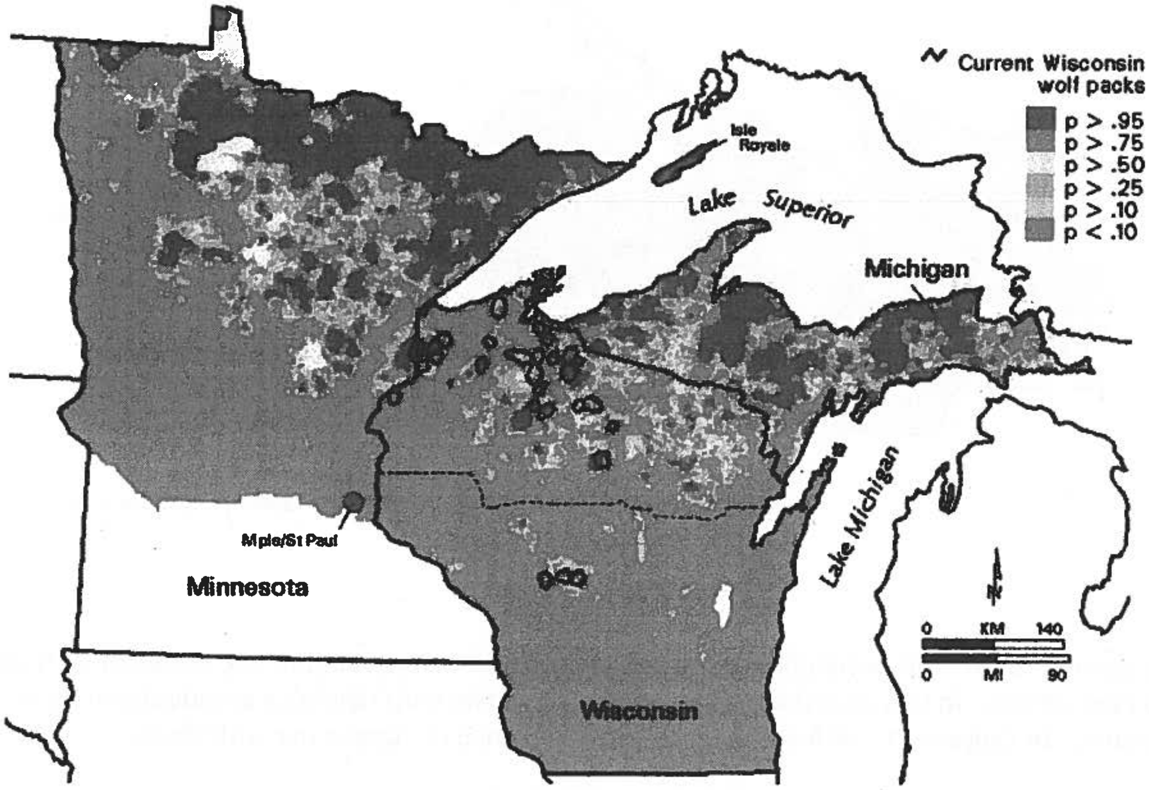

# MODEL RESULTS

After habitat values were calculated for each pack and non-pack area, variables correlated with other variables were dropped. For example, human population density and percent of private land are correlated to road density and were therefore dropped from the analysis.

Road density proved to be the strongest predictor of wolf pack presence. Our logistic regression analysis predicts a greater than 50% chance of a wolf pack occurring where road densities are less than 0.45 km/sq km.

# MODEL APPLICATIONS

## FAVORABLE HABITAT PREDICTION



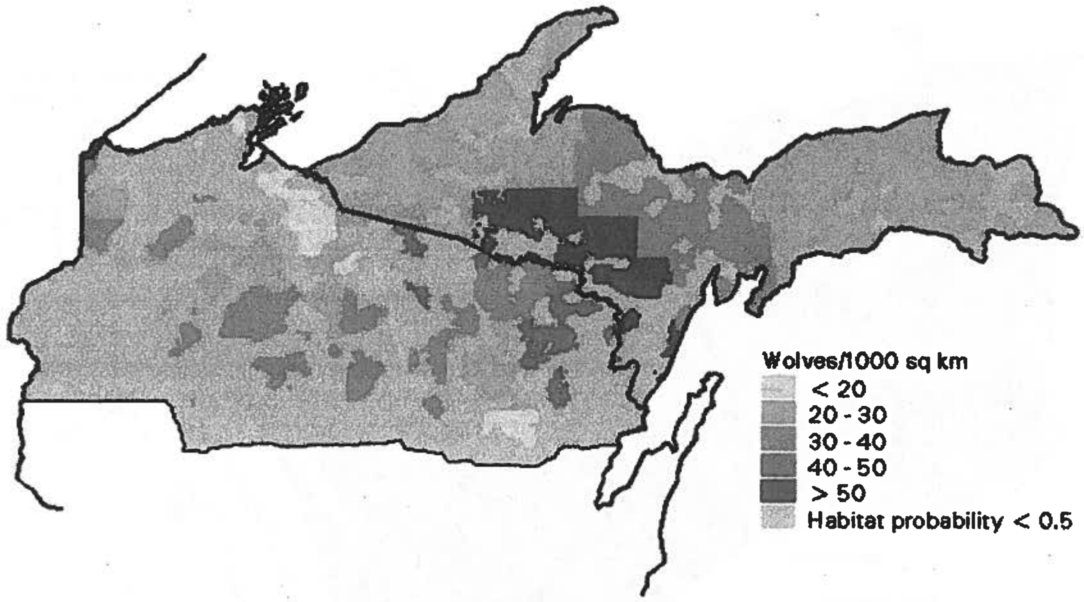

The above map shows the results of the logistic regression model applied to the northern Great Lakes region. Blue shading represents those areas where wolf packs are least likely to occur. Red shading represents those areas where wolf pack are most likely to occur. Note that Minnesota contains the largest amount of favorable habitat (50,200 sq km). Michigan contains 29,400 sq km of favorable habitat, while Wisconsin contains 15,400 sq km of favorable habitat.

## WOLF POPULATION ESTIMATES

Two methods of predicting future wolf populations in the region were used: (1) estimates based on the amount of favorable habitat, and (2) estimates based on the availability of deer.

Favorable habitat is defined here as those areas with a greater than 50% chance of supporting a wolf pack (yellow, orange, and red on the map above). Based on the predicted amount of favorable habitat that occurs in Wisconsin and Michigan, the following wolf population estimates were calculated:

- Wisconsin 357 wolves (90% CI 276-413)
- Michigan 705 wolves (90% CI 545-815)




The second set of wolf population estimates were based on the relationship between wolf density and prey density, in this case deer. The above map shows wolf densities as calculated from deer densities, for those areas with a greater than 50% chance of supporting wolf packs.

The following wolf population estimates were determined by multiplying the wolf densities by the areas they represent:

- Wisconsin 462 wolves (90% CI 262-662)
- Michigan 969 wolves (90% CI 829-2019)

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# CONCLUSIONS

- Wisconsin and Michigan are experiencing a strong recovery in their wolf populations, which had been extirpated by 1960.
- Recolonization has occurred by virtue of a large and stable population in adjacent northeastern Minnesota.
- Results from the logistic regression model show that potential wolf habitat in northern Wisconsin is highly fragmented, broken up by devolopment corridors. This may contribute to the low level of recolonization activity in northeastern Wisconsin.
- Potential wolf habitat in upper Michigan occurs in larger, more contiguous blocks than in Wisconsin. This area could maintain a significant wolf population that would be capable of serving as a source for Wisconsin, should increased development and fragmentation make wolf movement across northern Wisconsin more difficult.
- Wisconsin appears capable of supporting approximately 350-450 wolves. Michigan appears capable of supporting approximately 700-950 wolves.
- In general, public attitudes toward wolves has grown significantly more tolerant in the last two decades. As wolf numbers increase, however, there is likely to be a corresponding increase in conflict between wolves and humans and between wolf abundance and other biodiversity values.

# BIBLIOGRAPHY

For further information and a complete explanation of the information displayed on this web page, please see:

Mladenoff, D.J., R.G. Haight, T.A. Sickley, and A.P. Wydeven, 1996. Causes and implications of species restoration in altered ecosystems: A spatial landscape projection of wolf population recovery. Bioscience 47: 21-31.

Mladenoff, D.J., T.A. Sickley, R.G. Haight, and A.P. Wydeven, 1995. A landscape analysis and prediction of favorable gray wolf habitat in the northern Great Lakes region. Conservation Biology 9:279-294.

U.S. Fish and Wildlife Service, 1992. Revised recovery plan for the eastern timber wolf.

Wydeven, A.P., R.N. Schultz, and R.P. Thiel, 1995. Gray wolf (canis lupus) population monitoring in Wisconsin, 1979-1991. In L.N. Carbyn, S.H. Fritts, and D.R. Seip, eds. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, University of Alberta, Edmonton, Canada.

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STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

IIFER M. GRANHOLM
GOVERNOR

STEVEN E. CHESTER
DIRECTOR

September 14, 2005

Mr. Jon Cherry
Kennecott Minerals Company
1004 Harbor Hill Drive
Suite 103
Marquette, Michigan 49855

Dear Mr. Cherry:

We are responding to your requests made at our August 31, 2005, meeting regarding your proposed activities on the Eagle mineral deposit. In this meeting, you requested that we determine if Rule 323.1098 would apply to the mercury situation and, if so, how Subsection (4)(b) of the Rule would be applied.

At the meeting, the situation you described was for a groundwater discharge of 430,000 gallons per day to rapid infiltration beds. This discharge would be treated with hydroxide precipitation, ion resin (for boron), neutralization, and reverse osmosis prior to discharge. The primary source of wastewater was from the mine dewatering, with a limited amount coming from onsite runoff. Any process piles onsite would be covered to prevent contact with storm water. The estimated mercury discharge concentration from this treatment system was at or less than 1 ng/l.

The groundwater situation described was that the mine dewatering water originates from an aquifer that is deeper than, and isolated from, the shallow aquifer receiving the discharge. The shallow aquifer moves in a northeast direction and will vent to an eastern tributary of the Salmon Trout River about 5000 feet from the discharge area. The average groundwater flow rate in the shallow aquifer is presently estimated at about 100 to 200 feet per year, with travel times to the eastern tributary of the Salmon Trout River estimated to be 10 to 30 years. The mercury concentration in the surface aquifer is about 0.5 ng/l and the mercury concentrations found in the Salmon Trout River vary between 1 and 4 ng/l, with the higher concentrations found generally in the spring time. We have determined that the Salmon Trout River has a low flow of about 1.2 cubic feet per second (cfs) and a harmonic mean flow of 2.1 cfs near the crossing point with the Triple A Road.

Based on this information, we have the following preliminary determinations:

1. This is an activity pursuant to Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, that is anticipated to result in a new loading of pollutants, specifically mercury, to the surface waters of the state. This activity also requires compliance with Water Quality Standards. Therefore, based on the information presented to date, we believe that Rule 323.1098 applies to this activity.
2. Regarding the application of Rule 323.1098(4) (b), this subrule will apply for the mercury anticipated in the discharge. Specifically, (b) (i) and (b) (iii) of the subrule will be the applicable portions of this subrule. Kennecott must evaluate both of these portions and propose to the Department of Environmental Quality (DEQ) how these requirements will be fulfilled. For (b) (i), the demonstration needs to address how Kennecott will minimize the new loading of mercury by implementation of cost-effective pollution prevention

Mr. Jon Cherry
Kennecott Minerals Company
Page 2
September 14, 2005

techniques. For (b) (iii), Kennecott must provide an evaluation of the most advanced treatment techniques which have been adequately demonstrated and are reasonably available. Kennecott may also propose innovative or experimental technology for consideration.

3. Please note that the Antidegradation Demonstration must address all nine of the Lake Superior basin-bioaccumulative substances of immediate concern (LSB-BSIC), as listed in Rule 323.1043(pp).
4. It also appears that a mercury limit of 1.3 ng/l will be applied to this discharge. Using the assumption that the treated discharge will be at or less than 1 ng/l before the Rapid Infiltration Beds, this discharge will meet the water quality requirements.

We also understand that Kennecott is planning on collecting additional data pertaining to the shallow aquifer, including a shallow aquifer test. Please note that we need a final determination on the hydrogeological studies to be submitted as part of the groundwater discharge permit application.

These preliminary determinations are based on the information we received at the meeting, and are subject to change as more information becomes available. If you have any questions, please contact Eric Chatterson, at 517-241-1358, or you may contact me.

Sincerely,

William Creal

William Creal, Chief
Permits Section
Water Bureau
517-355-4114

wc/sea

cc: Eric Chatterson
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