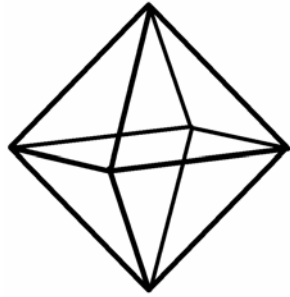


Application



Kennecott
Eagle Minerals

Eagle Project
Mining Permit Application
Volume II
Environmental Impact Assessment

Project I.D.: 04W018

Kennecott Eagle Minerals Company
Marquette, Michigan

February 2006



Printed on Recycled Paper

Eagle Project

Mining Permit Application
Volume II
Environmental Impact Assessment

Project ID: 04W018

Prepared for
Kennecott Eagle Minerals Company
ISO 14001:2004 Registered System

Prepared by
Foth & Van Dyke and Associates, Inc.

February 2006

Eagle Project Environmental Impact Assessment

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Note: The appendices listed above are contained in the following volumes:

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Volume IIB: Appendix B-5 (1 of 3)
Volume IIC: Appendix B-5 continued (2 of 3)
Volume IID: Appendix B-5 continued (3 of 3)
Volume IIE: Appendix B-6 through B-10
Volume IIF: Appendix C through G
Volume IIG: Appendix H through Appendix I-1
Volume IIH: Appendix I-2 through I-4

Eagle Project

Mining Permit Application

List of Abbreviations, Acronyms, and Symbols

CHMM	Certified Hazardous Materials Manager
CFA	Commercial Forestry Act
cfs	cubic feet per second
CL	Clay
COSA	Coarse ore storage area
CQA	Construction Quality Assurance
CR	County Road
CWB	Contact water basins
EIA	Environmental Impact Assessment
°F	degrees Fahrenheit
ft	Feet
gpm	gallons per minute
ha	Hectare
HGM	Hydrogeomorphic model
IRSL	Initial Risk Screening Level
ISCST3	Industrial Source Complex Short - Term
ITSL	Initial Threshold Screening Level
KEMC	Kennecott Eagle Minerals Company
km	kilometer
KME	King and MacGregor Environmental, Inc.
kW	kilowatt
m	meters
MCL	Michigan Compiled Laws
MCRC	Marquette County Road Commission
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MHPO	Michigan Historic Preservation Office
ML	silt
mph	miles per hour
MSL	Mean Sea Level
MVAR	Main ventilation air raise
mW	megawatt
NAAQS	National Ambient Air Quality Standards
NCWIB	Non-contact water infiltration basins
NRCS	Natural Resources Conservation Service
NREPA	Michigan Natural Resources and Environmental Protection Act
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
P.E.	Professional Engineer
P.G.	Professional Geologist
P.H.	Professional Hydrologist
Ph.D.	Doctorate of Philosophy
PIPP	Pollution Incident Prevention Plan

List of Abbreviations (*cont'd*)

ppt	parts per trillion (nanograms per liter – ng/l)
PTE	Potential to Emit
PWS	Professional Wetland Scientist
QAPP	Quality Assurance Project Plan
RPA	Registered Professional Archaeologist
SCR	Selective catalytic reduction units
SPCC Plan	Spill Prevention and Containment and Countermeasure Plan
SOP	Standard Operating Procedures
SM	silty sand
SP	poorly graded sand
SP-SM	poorly graded sand with silt
SRSL	Secondary Risk Screening Level
SW	well graded sand
TAC	Toxic Air Contaminants
TDRSA	Temporary Development Rock Storage Area
TDS	total dissolved solids
TWIS	Treated water infiltration system
ug/m ³	micrograms per cubic meter
U.P.	Upper Peninsula
USC	United States Code
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFS	U.S. Forest Service
WWTP	Wastewater Treatment Plant
WCR	Wetland and Coastal Resources, Inc.
W/m ²	watts per square meter
WSRA	Wild and Scenic Rivers Act

1 Introduction

Kennecott Eagle Minerals Company (KEMC) is proposing to develop an underground nickel and copper mine known as the Eagle Project in Michigamme Township, Marquette County, Michigan. This project location is shown in Figure 1-1. As part of the permitting process for the project, KEMC needs to apply for a Mining Permit in accordance with Part 632 of the Michigan Natural Resources and Environmental Protection Act (NREPA) (MCL §324.63201 et. seq.). This volume (Volume II) of the *Mining Permit Application* contains the *Environmental Impact Assessment* (EIA) for the Eagle Project. Appendices associated with this EIA are contained in Volume IIA through Volume IIH. This EIA has been prepared based on engineering and other environmental studies as they relate to the design, construction, operation, closure, reclamation, and post-closure care of the Eagle Project facilities.

1.1 Professional Qualifications

This EIA was prepared by Foth & Van Dyke and Associates, Inc. under contract to KEMC. This document incorporates information prepared by other qualified professionals working under contract to Kennecott and/or Foth & Van Dyke. Table 1-1 is a summary of the organizations and individuals who have contributed to the preparation of this EIA for the Eagle Project.

Table 1-1
List of Qualified Professionals

Organization	Individuals	Qualifications
BHE Environmental 11733 Chesterdale Rd Cincinnati, OH 45246	Christopher Bergman, Ph.D, RPA	Archaeologist
ECT, Inc. 501 Avis Dr Ste 5C Ann Arbor, MI 48108	Donald Tilton, Ph.D., PWS	Wetland Scientist
Fletcher Driscoll & Associates, LLC 1560 221 st Ave. NW Oak Grove, MN 55011	Tom Davis, P.G.	Professional Geologist
Foth & Van Dyke 2737 S Ridge Rd Green Bay, WI 54304	Stephen V. Donohue, P.H. John Starke, P.E. Steven Dischler, P.E. Ronald Meister, P.G. Janis S. Kesy, P.G. John Fassbender, P.E. Andrea Martin, P.E. Curtis Dungey, CHMM Gerald Eykholt, Ph.D., P.E. Michael Liebman, P.E.	Professional Hydrologist Professional Engineer Professional Engineer Professional Geologist Professional Geologist Professional Engineer Professional Engineer Air Quality/Meteorology Professional Engineer Professional Engineer

Table 1-1 *con't*

Organization	Individuals	Qualifications
Golder Associates, Inc. 44 Union Blvd Ste 300 Lakewood, CO 80228	Scott H. Miller, P.G David Regalbutto, P.G. David Bare John Wozniewicz Kevin Beauchamp, P.E. Willy Zawadzki, P.G.	Professional Geologist Professional Geologist Air Quality/Meteorology Hydrogeologist Professional Engineer Professional Geologist
Kennecott Eagle Minerals Company 1004 Harbor Hills Dr Ste 103 Marquette, MI 49855	Jonathan Cherry, P.E. Andrew Ware Alicia Duex	Professional Engineer, Manager Environment and Governmental Affairs Exploration Geologist Environmental Scientist
Kennecott Exploration #354-200 Granville St Vancouver, B.C. V6C 1S4	Dean Rossell Steven Coombes	Exploration Geologist Exploration Geologist
Kennecott Minerals Company 224 North 2200 West Salt Lake City, UT 84116	Fred Fox	Director Health, Safety, Environment and Reclamation
King & MacGregor Environmental Inc. 2520 Woodmeadow Dr SE Grand Rapids, MI 49546	Doug Workman, Ph.D., PWS	Aquatic Scientist
McIntosh Engineering 1438 W Broadway Rd Ste 101 Tempe, AZ 85282	Sandy Watson	Mining Engineer
North Jackson Company 1004 Harbor Hills Dr PO Box 218 Marquette, MI 49909	Daniel Wiitala, P.G. Kari Paulson	Professional Geologist Engineering Geologist
Rio Tinto Technical Services 5295 South 300 West Ste 300 Murray, UT 84107	Roger Sawyer	Engineer
Wetland Coastal Resources 5801 W Michigan Ave Lansing, MI 48917	Hal Harrington Mike Nurse Stuart Kogge Carl Bennett	Biological Team Leader Wetland/Aquatic Scientist Wetland/Aquatic Scientist Wildlife Biologist

1.2 EIA Methodologies and Sources of Information

The following is a list of sources of information that have been used in the preparation of this EIA:

- ♦ Aiello, C. 2004. Michigan Water Chemistry Monitoring Great Lakes Tributaries 2002 Report. MI/DEQ/WD-04/049.
- ♦ Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press.
- ♦ BHE Environmental, Inc. September 2005. Phase I Archaeology Survey of the CA. 73 Acres of the Kennecott Minerals Company Eagle Project, Marquette County, Michigan (EIA Appendix H-1).
- ♦ Brinson, M.M. 1993a. A Hydrogeomorphic Classification for Wetlands. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS, USA. Wetlands Research Program Technical Report WRP-DE-4.
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- ♦ Creal, W., S. Hanshue, S. Kosek, M. Oemke and M. Walterhouse. 1998 Update of GLEAS Procedure 51 Metric Scoring and Interpretation June 1996. Revised May 1998.
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- ♦ Fanning, D.S. and M.C.B. Fanning 1989. Soil Morphology, Genesis, and Classification. John Wiley & Sons, New York.
- ♦ Fletcher Driscoll Associates, Inc. February 2006. Predictive Assessment Modeling of the Quaternary Alluvium Hydrogeology – Eagle Project.
- ♦ Foth & Van Dyke and Associates, Inc. 2005. Eagle Project Michigan Air Use Permit – Permit to Install Application (submitted to MDEQ).
- ♦ Foth & Van Dyke and Associates, Inc. 2006. Eagle Project Groundwater Discharge Permit Application (submitted to MDEQ).
- ♦ Geochimica, Inc. June 2004. Report on Phase I Investigations, Eagle Project Acid Rock Drainage Study. Marquette County Michigan (see Volume I – Appendix List).
- ♦ Geochimica, Inc. June 2005. Report of Investigations, Eagle Project, Marquette County Michigan. Geochemistry – Phase II (see Volume I – Appendix List).

- ♦ Geochimica, Inc. June 2005. Technical Memorandum. Total Metals in Solids from Ore (contained in Foth & Van Dyke 2005).
- ♦ Geochimica, Inc. March 2005. Technical Memorandum. Total Metals in Solids from Development Rock (contained in Foth & Van Dyke, 2005).
- ♦ Geochimica, Inc. January 2006. Technical Memorandum – Underground Water Quality at End of Mining with All Development Rock Backfill (see Volume I – Appendix List).
- ♦ Geochimica, Inc. November 2005. Technical Memorandum. Water Quality from the Development Rock Storage Pad During Operations (see Volume I – Appendix List).
- ♦ Geochimica, Inc. November 2005. Technical Memorandum. Water Quality in Underground Mine During Operations (see Volume I – Appendix List).
- ♦ Golder Associates, Inc. November 2005. Kennecott Eagle Minerals Company Eagle Project Environmental Baseline Summary (EIA Appendix A).
- ♦ Golder Associates, Inc. October 2004. Eagle Project Environmental Baseline Study – Summary Data Report Stage I (previously submitted to MDEQ).
- ♦ Golder Associates, Ltd. April 2005. Eagle Project Geotechnical Study (see Volume I – Appendix List).
- ♦ Golder Associates, Inc. April 2005. Kennecott Minerals Company Eagle Project. Environmental Baseline Study - Bedrock Hydrogeologic Investigation (EIA Appendix B-2).
- ♦ Golder Associates Inc. September 2005. Stage 2 Report on the Surficial Geology and Terrain of the Proposed Kennecott Eagle Project (EIA Appendix C).
- ♦ Golder Associates Inc. September 2005. Stage 2 Report on the Air Quality and Meteorology of the Proposed Kennecott Minerals Company Eagle Project (EIA Appendix I-1).
- ♦ Golder Associates, Ltd. February 2006. Eagle Project Additional Geotechnical Scope (see Volume I – Appendix List).
- ♦ Golder Associates, Inc. February 2006. Eagle Project Phase II Bedrock Hydrogeology Investigation (EIA Appendix B-3).
- ♦ Golder Associates Inc. February 2006. Bedrock Hydrogeologic Modeling to Assess Inflow to Proposed Eagle Project (EIA Appendix B-4).
- ♦ John Meier. January 2006. Memorandum on Gentian Plant Survey (EIA Appendix F-2).
- ♦ Kennecott Exploration Company. April 2005. The Geology of the Eagle Nickel - Copper Deposit. Michigan, USA (see Volume I – Appendix List).

- ♦ Kohler, M.A. T. Nordenson, and D. Baker. 1959. Evaporation Maps for the United States. U.S. Weather Bureau Technical Paper 37. Washington, DC.
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- ♦ Newman, L.E. and R.B. DuBois. 1996. Status of Brook Trout in Lake Superior. Prepared for Lake Superior Technical Committee.
<http://www.fws.gov/midwest/ashland/brook>.
- ♦ Newman, L.E. R.B. DuBois, and T.N. Halpern (editors). 2003. A Brook Trout Rehabilitation Plan for Lake Superior. Great Lakes Fisheries Commission Miscellaneous Publication 2003-03.
- ♦ North Jackson Company. January 2006. Technical Memorandum. Eagle Project, Bioaccumulative Sampling (EIA Appendix B-9).
- ♦ North Jackson Company, Inc. February 2006. Comprehensive Summary of Hydrogeologic Reports (EIA Appendix B-1).
- ♦ North Jackson Company, Inc. September 2005. Eagle Project, Environmental Baseline Study Hydrology Report (EIA Appendix B-5).
- ♦ North Jackson Company, Inc. January 2006. Eagle Project Supplemental Wetland Hydrology Baseline Study (EIA Appendix B-6).
- ♦ North Jackson Company, January 2006. Supplemental Hydrogeologic Study for Groundwater Discharge (EIA Appendix B-8).
- ♦ North Jackson Company. September 2004a. Hydrological Assessments Standard Operating Procedures (previously submitted to MDEQ).
- ♦ North Jackson Company. September 2004b. Quality Assurance Project Plan for Stage 2 Hydrological Assessments (previously submitted to MDEQ).
- ♦ Scott, W.B. and E.J. Crossman. 1973. Freshwater Fisheries of Canada. Fisheries research Board of Canada.

- ♦ Scribner, K.T. 2004. Effects of Exploitation and Fisheries Management on Genetic Diversity in Fish Stocks in Inland and Great Lakes Waters of Michigan. Study Performance Report. Project Number: F-81-r-5. Michigan Department of Natural Resources Fisheries Division. 4pp.
- ♦ Van Deventer, J.S. and W.S. Platts, 1983. Sampling and Estimating Fish Populations from Streams. Transactions of the North American Wildlife and Natural Resources Conference. 48:349-354.
- ♦ Ward, A.D., and S.W. Trimble, 2004. Environmental Hydrology, 2nd Edition. Lewis Publishers, Boca Raton, FL.
- ♦ Wetland and Coastal Resources, Inc. September 2005. Aquatic Assessment Kennecott Minerals Company, Eagle Project. Marquette, MI (EIA Appendix G-1).
- ♦ Wetland and Coastal Resources, Inc. October 2005. Technical Memorandum Wildlife Transects and Habitat Mapping – Eagle Project (EIA Appendix E-2).
- ♦ Wetland and Coastal Resources, Inc. September 2005. Threatened and Endangered Species Assessment. Kennecott Minerals Company, Eagle Project. Marquette, MI (EIA Appendix F-1).
- ♦ Wetland and Coastal Resources, Inc. January 2006. Wetland Data Form Compilation (EIA Appendix D-2).
- ♦ Wetland and Coastal Resources, Inc. September 2005. Wetland Delineation Report. Kennecott Minerals Company, Eagle Project. Marquette, MI (EIA Appendix D-1).
- ♦ Wetland and Coastal Resources, Inc. September 2005. Wildlife Species Assessment. Kennecott Minerals Company, Eagle Project. Marquette, MI (EIA Appendix E-1).
- ♦ White Water Associates, Inc. 2005. Baseline Limnological Studies of Streams in the Vicinity of a Proposed Sulfide Mine in Marquette County, Michigan. Prepared for the Michigan Department of Environmental Quality (EIA Appendix G-2).

1.2.1 Quality Assurance and Quality Control and Documentation on Methodologies

As part of the baseline studies, KEMC provided to the Michigan Department of Environmental Quality (MDEQ) in the fall of 2004, a document summarizing ongoing baseline studies and proposed methodologies (Golder Associates, 2004). The methodologies used for collecting the baseline data presented in this EIA are described in work plans contained in the Golder Associates, Inc. 2004 report. KEMC also submitted Quality Assurance Project Plans (QAPP) and Standard Operating Procedures (SOPs) for the hydrologic data collection program (North Jackson 2004a and 2004b). These documents were received and reviewed by the MDEQ.

1.3 Public Input

As part of the development of plans for the Eagle Project, KEMC held numerous meetings with interested parties. These informational meetings took place through KEMC's Community Advisory Group that consisted of representatives from regulatory agencies, local government, business groups, environmental organizations and academic institutions. The plans for the Eagle Project as described in Volume I of this *Mining Permit Application* reflect the input from these parties. Specific Community Advisory Group meetings and the meeting topics were as follows.

- ♦ October 18, 2004 - Advisory group charter and project update.
- ♦ January 31, 2005 - Project update; ISO 14001 certification; acid rock drainage program.
- ♦ May 2, 2005 - Site tour.
- ♦ August 4, 2005 - Project update; transportation options; preliminary site design.
- ♦ November 4, 2005 - Project update; contingency plans.
- ♦ December 19, 2005 - Project update; coaster brook trout.

KEMC plans to continue Community Advisory Group meetings through project operations and reclamation.

2 Summary of Proposed Action

The Eagle deposit is a high-grade magmatic sulfide deposit containing nickel and copper and trace amounts of cobalt and gold. Figure 1-1 shows the project location. As displayed in Figure 2-1, the project area is located in Sections 11 and 12 T50N-R29W in Michigamme Township on land that is zoned for mineral resource production. Surface ownership in the vicinity of the project is shown in Figure 2-2. Surface facilities to support the operation are shown on Figure 2-3. A schematic of the underground mining process is displayed in Figure 2-4. A detailed description of the mining operation is provided in Volume I of this *Mining Permit Application*. The following is a summary of the key aspects of the operations as it relates to the assessment of potential environmental impacts documented in this EIA:

- ◆ Electric power for the project will be provided by on-site diesel-fueled generators.
- ◆ Propane fired heaters will augment mine air heating requirements.
- ◆ The ore body will be accessed via underground mining methods as displayed on Figures 2-3 through 2-5.
- ◆ Development rock that is generated to access the ore body will be amended with limestone and temporarily stored in a lined facility referred to as the temporary development rock storage area (TDRSA).
- ◆ As the TDRSA is filled, a geomembrane will be placed over the development rock as a temporary cover to minimize the generation of contact water that is collected in the TDRSA.
- ◆ Through a network of underground ramps and the main mine decline, ore will be trucked to the surface where it will be temporarily stored at the contained coarse ore storage area (COSA).
- ◆ Ore will be transferred from the COSA to an enclosed crusher where the rock will be crushed and transferred to storage bins.
- ◆ Ore from the storage bins will be transferred to haul-trucks that will transport the ore to a railhead that will be located in the vicinity of Marquette Michigan. The haul trucks will use secured covers during transport to control spillage and potential fugitive emissions. The location of the railhead has not yet been determined.
- ◆ The transportation route is displayed in Figure 2-6 (CR 550 proposed option) and follows approved existing transportation routes. KEMC will be working with the Marquette County Road Commission (MCRC) on improvements to the Triple A Road and County Road 510 to support safe transportation.
- ◆ Storm water runoff from the main operations area will be routed to lined contact water storage basins (CWBs) for temporary storage.

- ♦ Water pumped from the underground mine will be pumped to the CWBs for temporary storage prior to treatment.
- ♦ Water in the CWBs will be pumped to the wastewater treatment plant (WWTP) where it will be treated to comply with MDEQ groundwater quality standards.
- ♦ The WWTP will consist of a hydroxide precipitation process, a reverse osmosis process, ion exchange and an evaporator/crystallizer to produce an effluent that surpasses drinking water requirements.
- ♦ Treated water will be discharged to a buried infiltration system referred to as the treated water infiltration system (TWIS). At the TWIS, the treated water will be infiltrated into the subsurface.
- ♦ Storm water runoff from the non-contact area (outside the main operations area) will be routed to non-contact water infiltration basins (NCWIBs) where runoff water will be allowed to infiltrate back to the subsurface.
- ♦ The backfill surface facility will be located west of the main surface facility and will contain storage silos for fly ash and Portland cement and a clean aggregate stock pile. Clean aggregate will be provided from a local quarry operator.
- ♦ The main ventilation shaft will also be located at the backfill surface facility.
- ♦ At the backfill surface facility, aggregate, fly ash and cement will be passed underground through bore holes and an aggregate raise to an underground backfill mixing plant (see Figure 2-4 and 2-5).
- ♦ The mixing plant will mix the aggregate with fly ash and cement. This material will be transported underground to backfill primary mining stopes. All primary mining stopes will be backfilled with cemented backfill.
- ♦ Limestone amended development rock in the TDRSA will be transported underground and used to backfill secondary mining stopes.
- ♦ As part of reclamation activities various underground openings will be cemented to protect groundwater quality in the aquifer at the Eagle Project site.
- ♦ Surface reclamation will result in the complete removal and restoration of the surface facilities area to a state consistent with existing conditions.
- ♦ Operational and post-closure monitoring will be completed to confirm protection of natural resources.

- ♦ Financial assurance in the amount of \$11,370,460 will be provided by KEMC prior to the initiation of construction per R 425.401. The financial assurance covers anticipated reclamation costs, environmental monitoring costs, administrative oversight and an amount for environmental contingencies.
- ♦ In addition to the environmental protection measures built into the Eagle Project's operational plans, reclamation plans, contingency plans and monitoring plans, the financial assurance acts as an additional mechanism to ensure that natural resources around the Eagle Project site are protected.

Section 3 of this EIA assesses potential impacts to each resource topic included in the R 425.202(2). An alternatives analysis is provided in Section 4.

3 Environmental Assessment

For each resource topic included in this assessment, existing conditions are described per R 425.202(1)(a)(i). Proposed mining activities that may affect each resource are presented and the potential impact from the activity is described as required in R 425.202(1)(a)(ii)-(iii). Measures that will be completed in accordance with the plans described in Volume I of this *Mining Permit Application* to reduce and mitigate impacts are presented per R 425.202(1)(a)(iv). Cumulative impacts that may occur are presented throughout this section.

3.1 Scope of Environmental Impact Assessment

The environmental studies that were completed for the Eagle Project EIA comply with the requirements of R 425.202. Resource topics that are evaluated for this EIA include the following:

- ♦ Topography,
- ♦ Soil,
- ♦ Geology of the bedrock and unconsolidated materials overlying the bedrock,
- ♦ Groundwater and aquifers,
- ♦ Surface water systems,
- ♦ Regional hydrology,
- ♦ Groundwater and surface water quality,
- ♦ Private and public water supplies including irrigation wells,
- ♦ Designated wellhead protection areas,
- ♦ Wetlands and flood plains,
- ♦ Natural rivers,
- ♦ Wild and scenic rivers,
- ♦ Residential dwellings, schools, and other public and private structures,
- ♦ Existing and proposed infrastructure,
- ♦ Natural areas,
- ♦ State wilderness areas,
- ♦ Federal wilderness areas,
- ♦ Wild areas,
- ♦ Research natural areas,
- ♦ Land use,
- ♦ Aquatic and terrestrial flora and fauna,
- ♦ Fish and wildlife habitat and ecological systems
- ♦ Threatened and endangered species and species of special concern,
- ♦ Non-native and invasive species,
- ♦ Archaeological resources,
- ♦ Air quality and meteorology,
- ♦ Visual resources, and
- ♦ Noise, light and seismicity.

All these topics are addressed in Section 3. Section 4 addresses prudent and feasible alternatives to various aspects of the Eagle Project.

Extensive effort was put forth by KEMC in conducting the baseline environmental studies documented in this EIA and determining the areas that are subject to potential affects from mining activities. The studies that were performed for this EIA varied in scope depending on the resource issue. For water resource related topics of groundwater and surface water, the study area encompassed the Salmon Trout River watershed, portions of the Yellow Dog River watershed and the Cedar Creek watershed (see Figure 3-1). For aquatic resources, the study area encompassed the Salmon Trout River Main Branch, the Yellow Dog River south of the Eagle Project site and Cedar Creek. For wetlands, threatened species, endangered species, species of special concern, terrestrial flora and fauna, and habitat, the study area encompassed approximately 1,360 acres around the 145 acres that will be used for the Eagle Project. Similarly, approximately 199 acres around the project facilities were included in the archaeological study area. In all of these cases, the study area was larger than the area of potential impact. As described in Section 3, the area of potential impact is constrained to approximately 92-acres of land that will be disturbed for construction and the lands immediately adjacent to this area of disturbance. For hydrologic related impacts the area of potential impact is the area of potential groundwater drawdown, an area within an area that is less than a 1/3-mile radius of the underground mine, and streams that are potentially affected by mine dewatering. It should be noted that the area potentially affected by mining operations does not equate to an unacceptable impact. The purpose of this EIA is to disclose potential impacts and changes to the local environment due to the mining operations that are regulated under the environmental permits that KEMC is applying for. As such, the EIA is correctly viewed as a disclosure document.

The study areas for other topics such as natural rivers, infrastructure, places of business, and aesthetics are defined by their occurrence within several miles of the project site. Appendix A provides a summary of the baseline studies completed by KEMC for this EIA. These KEMC commissioned studies are described in detail in Appendices B through I of this EIA.

3.2 Topography and Drainage

The assessment of potential impacts on topography and drainage as required under R 425.202(2)(a) are provided in this section.

3.2.1 Existing Conditions in the Study Area

The Eagle Project is located on a broad relatively flat lying sandy plain comprised of a thick deposit of glacial fluvial materials consisting of fine grained lacustrine deposits and outwash sand. Located near the surface drainage divides of the Salmon Trout River and the Yellow Dog River as shown in Figure 3-1, the topography in the study area, is characterized as follows:

- ◆ The topography of the approximately 27 mi² of the Yellow Dog Plains, is relatively flat with localized surface relief adjacent to erosional streams and drainage ways.
- ◆ South of the Yellow Dog River, the plains are bounded by igneous and metamorphic bedrock that rises above the plains and exhibits substantial topographic relief.
- ◆ To the north, the Yellow Dog Plains is bounded by a steep terraced escarpment of glacial moraine referred to in this EIA and supporting reports as the north terrace.

The Salmon Trout River watershed covers approximately 50 mi². The Salmon Trout River flows into Lake Superior at Salmon Trout Bay. Five notable features with respect to hydrology and habitat on the Salmon Trout River are located within several miles of the Lake Superior shoreline (but downstream of the mining area). These features include three waterfalls (Upper Falls, Middle Falls and Lower Falls) and two dams (Burnt Dam and Lower Dam). The upper portion of the Salmon Trout River is sub-divided into three sub-watersheds:

- ♦ The Salmon Trout River Main Branch covering approximately 8.8 mi²,
- ♦ The Salmon Trout River East Branch covering approximately 13 mi², and
- ♦ The Salmon Trout River West Branch covering approximately 3.3 mi².

The Yellow Dog River watershed covers approximately 98 mi². The river flows easterly and drains into Lake Independence which then drains to Lake Superior. For more detailed information on the studied watershed, the reviewer is directed to Appendix B-1 and Appendix B-5 which contain the baseline studies on regional hydrology and geology. The mine area (approximately 92 acres of disturbed land) is located predominantly within the watershed of the Salmon Trout River Main Branch. The only portion of the project site located in the Yellow Dog River watershed is the main access road and the southeastern fringe of the main surface facility which accounts for about 14.6 acres of the disturbed area (see Figure 3-1 and Figure 3-2). The only theoretical potential affect on the Yellow Dog River watershed from this portion of the surface facility is related to the drainage and potential erosion along the access road. The storm water runoff from the access road will be routed to NCWIBs for sediment retention and infiltration of storm water so there will be no off-site erosion and sedimentation. The access road is also more than 1-mile from the Yellow Dog River. As such there will be no measurable impact on the Yellow Dog River watershed due to the construction and operation of the surface facilities. The remainder of this subsection, therefore focuses on an evaluation of potential topographic and drainage impacts on the watershed of the Salmon Trout River Main Branch.

Figure 3-2 and 3-3 shows the topography in the vicinity of the surface facilities. The surface facilities area is defined as the fenced-in area of the Eagle Project facilities and disturbed land areas around the access roads to the main surface facility and backfill facility. The total facility foot print (fenced area and access roads) is approximately 145 acres. The total land area that will be disturbed as part of site operations and reclamation is approximately 92-acres, as mentioned above of that area, approximately 77.5 acres resides in the Salmon Trout River Main Branch.

Not including the aforementioned area around the access road, the topography in the surface facilities area is characterized by flat topography that gently slopes to the southwest toward the Salmon Trout River Main Branch. Within the fenced area around the main surface facility is a peridotite rock outcrop that rises over 50 feet above the surrounding plains. This rock outcrop will be used to construct the portal to the mine (Figures 2-3 through 2-5).

3.2.2 Proposed Activities Affecting Topography and Drainage

The mining activities that could affect topography and drainage include:

- ♦ Construction of the surface facilities
- ♦ Management of storm water runoff
- ♦ Reclamation of the surface facilities

3.2.3 Potential Impacts on Topography and Drainage

During construction, earth moving equipment will remove and stockpile topsoil, grade the site in accordance with the storm water management plan described in Volume I of this *Mining Permit Application* and complete excavations for the construction of the TDRSA, CWBs, NCWIBs and TWIS. Excess soils from the construction activities will be used to create an excess soil berm around the perimeter of the main surface facility. These topographic changes will exist throughout the operational phase of the project.

During operations, storm water management plans call for the on-site collection and treatment of all storm water runoff through either the WWTP or NCWIB. Thus during operations, storm water runoff from the operations area and non-contact area will be collected and treated pursuant to applicable regulations.

To access the mine, a mine portal will be constructed into the western face of the peridotite outcrop at the main surface facility. The surface dimensions of this portal are approximately 5.8-meters high by 7.2-meters wide. The portal will be constructed below the existing land surface as shown on Figure 4-7 in Volume I of this *Mining Permit Application*.

3.2.4 Mitigation of Topographic and Drainage Impacts

The reclamation plan will mitigate the short-term operations phase impact to topography. As a result of reclamation, the topography and drainage at the site will be restored to conditions that existed prior to site operations. All surface structures will be removed and the site will be seeded with a mixture of natural vegetation. The mine portal will be cemented and the western face of the outcrop will be restored with rock that was removed as part of portal construction. The excavated area around the mine portal will be regraded so that the sealed and restored opening is approximately below reclamation grades. Topographic and related drainage impacts are anticipated to be minimal throughout the project life.

3.3 Soils

The assessment of potential impacts to soil required in R 425.202(2)(b) is presented in this section.

3.3.1 Existing Soils Conditions in the Study Area

The study area for soils encompassed approximately 2-square miles around the surface facilities and consisted of the collection of soil cores for physical characterization and analysis of metals content (see Figure 3-4A and Appendix C). Two predominant types of glacial deposits exist within the proposed surface facilities area: a) glacial outwash (sand and gravel) and b) post-glacial organic deposits (e.g. peat) in wetland areas. The surficial soils derived from these deposits in the surface facilities areas are mapped as:

- ♦ Rubicon sand, zero to six percent slopes
- ♦ Rubicon sand, six to 18 percent slopes
- ♦ Sayner-Rubicon Complex, one to six percent slopes
- ♦ Rubicon-Ishpeming Rock Outcrop Complex, six to 25 percent slopes
- ♦ Rubicon-Ishpeming Rock Outcrop Complex, 25 to 60 percent slopes.

A map of the soil series at and on lands adjacent to the surface facilities is provided in Figure 3-4B. As documented in the surficial geology report in Appendix C, the combined thickness of the surface soil layer in the study area is typically no more than 8 to 12 inches and in some areas is non-existent.

The grain size analyses indicate the majority of the samples (90 percent) contained over 50 percent fine sand, and less than five percent silt. Visual and laboratory USCS classification, including Munsell color, are summarized in Table 1 of Appendix C. The laboratory measurements of grain size distribution are summarized in Table 2 of Appendix C. The visual and laboratory classifications indicate the majority of the soil samples are classified as poorly graded sand (SP). A minority of the samples are classified as poorly graded sand with silt (SP-SM); silty sand (SM); well graded sand (SW); and poorly/well graded sand with gravel. The small fraction of fines in the soil samples indicates the area should exhibit a rapid infiltration rate.

The testing indicates soil pH conditions in the northwest quarter of Section 12 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 exceed MDEQ-published Statewide Default Background Concentration levels specified in R 299.5746. Metal results are contained in Appendix C.

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.

3.3.2 Proposed Mining Activities Affecting Soils

Volume I of this *Mining Permit Application* lists the surface structures that support the mining activities. All of these surface structures will result in the disturbance of soils during the approximate 12-year period of mine construction, operation and reclamation.

Impacts to soils outside of the mining area due to deposition of airborne particulates released from the mine are projected to be negligible based on air modeling results documented in the *Michigan Air Use Permit – Permit to Install Application* for the Eagle Project (Foth & Van Dyke, 2005) and summarized in Section 3.17 of this EIA. Impacts to soils outside of the mine area due to erosion events caused by mining activities are expected to be immeasurable since storm water runoff will be managed/treated on-site through the WWTP or NCWIBs. As such potential impacts are limited to soil disturbance.

3.3.3 Potential Impacts on Soils

Potential soil disturbance impacts can be divided in two groups based on the lateral and vertical extent of soil excavation and/or soil filling. The first group includes structures that require

significant soil disturbance. Significant soil disturbance is described as an excavation or filling effort over a large area that involves a considerable quantity of soil. Contained in Volume I of this *Mining Permit Application* is the earthwork balance for the mine area that provides the estimated cut and fill quantities for the structures that have significant soil disturbance. A description of the extent and nature of soil disturbance is as follows:

- ♦ The mine area will be cleared and grubbed and the topsoil stripped and stockpiled. Figure 2-3 shows the location of the topsoil stockpile at the north end of the main surface facilities.
- ♦ CWBs are constructed by excavating to a depth of about 15 feet. A two foot high berm will be constructed around the CWB with excavated soil.
- ♦ NCWIBs are constructed by excavating to a depth of between eight and 10 feet. A two foot high berm will be constructed around each NCWIB. Soil excavated from the NCWIBs will be used to construct the excess soil berm shown on Figure 2-3.
- ♦ The TWIS is constructed by covering the five cells of infiltration piping with five feet of excess soil. Approximately 29,800 cubic yards of soil from site excavations is placed over the TWIS.
- ♦ The TDRSA is constructed by excavating the area to a typical depth of approximately nine feet. A berm is constructed around the TDRSA with the excavated soils. Soil excavated from the TDRSA is used to construct the soil berm.

Mining area structures that have *limited soil disturbance* in that they are generally constructed at grade include the:

- ♦ Truck wash
- ♦ Truck scales
- ♦ Fuel storage area
- ♦ Assay lab
- ♦ Crusher
- ♦ Maintenance shop and plant
- ♦ Crushed ore bins
- ♦ Core storage
- ♦ Coarse ore storage area
- ♦ Lay-down area
- ♦ Mine air heater
- ♦ Propane storage
- ♦ WWTP
- ♦ Underground day storage
- ♦ Portal
- ♦ Gate house
- ♦ Mine office
- ♦ Loading dock
- ♦ Emergency facilities
- ♦ Parking areas

- ◆ Backfill plant area

The structures listed above have very limited soil disturbance consisting of stripping and stockpiling of topsoil and shallow excavation needed for construction of foundations or concrete slabs. Topsoil from all disturbed areas will be stockpiled on-site and used for reclamation purposes.

3.3.4 Mitigation of Impacted Soils

Mitigation of impacts during soil excavation includes:

- ◆ Construction of erosion control devices in the mine area prior to earth moving.
- ◆ Stockpiling topsoil for use in reclamation activities.
- ◆ Reclamation of the mine area after completion of mining.

3.3.4.1 Soil Erosion Control During Construction and Operation and Reclamation

Soil erosion and sediment control during project construction operations and reclamation is provided in Section 4 of Volume I of this *Mining Permit Application*. The soil erosion and sediment control plan will accomplish the following environmental protection and mitigation goals for the project:

- ◆ Prevent sediment erosion into nearby wetlands and streams.
- ◆ Maintain topsoil removed during project construction for later use in reclamation activities.

3.4 Geology and Hydrology

The baseline studies, completed by KEMC, were designed to meet the baseline data requirements specified in R 425.202(2)(c) through R 425.202(2)(g) and R 425.202(3). Sections 3.4.1 through 3.4.1.5 summarize the baseline conditions as required in the rules.

3.4.1 Baseline Conditions

KEMC has dedicated extensive resources for the characterization of geologic/hydrogeologic and surface water conditions in the study area that encompasses the Salmon Trout River watershed, the Cedar Creek watershed, and portions of the Yellow Dog watershed south of the Eagle Project site. Commissioned studies that were completed by KEMC that address these conditions at the site are included in Appendix B of this EIA and include the following:

- ◆ North Jackson Company, Inc. February 2006. Comprehensive Summary of Hydrogeologic Reports.
- ◆ Golder Associates, Ltd. April 2005. Kennecott Minerals Company Eagle Project. Environmental Baseline Study – Bedrock Hydrogeologic Investigation.
- ◆ Golder Associates, Inc. February 2006. Eagle Project Phase II Bedrock Hydrogeologic Investigation.

- ♦ Golder Associates, Inc. February 2006. Bedrock Hydrogeologic Modeling to Assess Inflow to Proposed Eagle Project.
- ♦ North Jackson Company, Inc. September 2005. Eagle Project Environmental Baseline Study Hydrology Report.
- ♦ North Jackson Company, Inc. January 2006. Eagle Project Supplemental Wetland Hydrology Baseline Study.
- ♦ North Jackson Company, Inc. January 2006. Technical Memorandum Eagle Project Bioaccumulative Sampling.
- ♦ Fletcher Driscoll Associates, Inc. February 2006. Quaternary Aquifer and Stream Flow Predictive Assessment Modeling of Quaternary Alluvium Hydrogeology – Eagle Project.
- ♦ North Jackson Company, Inc. January 2006. Supplemental Hydrogeologic Study for Groundwater Discharge.

Reports relevant to the characterization of the Eagle Deposit and geotechnical conditions of the bedrock at the project site are presented in Appendix C of Volume I of this *Mining Permit Application*.

In addition to the characterization of the bedrock conditions at the project site, a primary focus of the baseline studies was directed at characterizing the hydrogeologic characteristics of the Quaternary deposits of glacial alluvium and the hydrologic characteristics of the rivers and wetlands in the studied watersheds. Figure 3-5 shows the locations of soil borings and monitoring wells that were completed for these purposes. Figure 3-1 displays the location of surface water monitoring stations that were used to characterize seasonal stream flow and water quality.

3.4.1.1 Geology of the Bedrock and Unconsolidated Deposits

The geology of the bedrock and Eagle Deposit is provided in Appendix C-1 of Volume I of this *Mining Permit Application* and Appendix B of this EIA.

The Yellow Dog Plains in northern Marquette County is composed of Precambrian rocks covered by glacial Quaternary and post-glacial Quaternary sediments. The bedrock beneath the plains is mostly metasedimentary rocks of the Michigamme Formation, part of the Marquette Range Supergroup of Proterozoic age rocks (roughly 2 billion years old). These metasedimentary rocks are contained in an east-west trending structural trough known as the Baraga Basin. This trough is flanked on the north, south, and east by gneiss and greenstone Archean basement rocks, older than 2.5 billion years. Because of the extensive Quaternary deposit cover on the plains, very little exposure of the Michigamme Formation exists in this area. The Archean basement rocks have numerous outcrop exposures surrounding the Baraga Basin (see Appendix B-1).

The Michigamme Formation beneath the Yellow Dog Plains consists of fine-grained clastic rocks, largely black slate and argillite. These rocks were deformed and metamorphosed to the greenschist facies about 1.9 billion years ago.

Emplaced into the Michigamme Formation are east to west-trending diabase dikes of early Keweenaw age that intruded about 1.1 billion years ago. The Yellow Dog Peridotite is present in the central Yellow Dog Plains, and is known from two outcrops located in T50N-R29W, Section 11 and 12, along one of these dike trends.

The geology of the Quaternary and post-glacial quaternary deposits is provided in Appendices B-1, B-5 and B-8 of this EIA.

The observed thickness of the Quaternary deposits within the study area ranges from 0 to 255 ft. The deposit thickens in all directions away from the Peridotite outcrops, with the greatest thickness observed at location QAL009, east of the Peridotite outcrop and at location QAL007, northwest of the Eagle Project area. The deposit thins toward the north and south, terminating at the boundary of the Archean bedrock formation at the southern edge of the Yellow Dog Plains and the Huron Mountains north of the Yellow Dog Plains (Appendix B-1 and Appendix B-5).

Descending the hydrostratigraphic column the following is a summary of the major hydrostratigraphic units identified within the Quaternary deposits (Appendix B-1 and Appendix B-5).

Outwash and Beach Deposits (A Zone)

The glacial outwash and beach deposits are coarse-grained, comprised of well-sorted, stratified fine- to medium-grained sand, with some gravel and minor quantities of silt and clay (USCS classification SP to SP/SP-SM). Excluding wetland locations where the water table is at or very near the ground surface, the minimum vadose zone thickness measured was about 5-8 ft at locations QAL005 and QAL006 (Figure 3-5). The maximum unsaturated zone thickness measured was in excess of 100 ft northeast of the proposed TWIS. An unconfined water table defined as the A Zone hydrostratigraphic unit occurs in the saturated portion of this deposit.

Transitional Deposit (B Zone)

A gradational contact exists between the A Zone outwash sand and deeper deposits that are finer-grained. This contact includes a transitional zone that contains a mix of fine sand, silt and clay (SM), fining downward to predominantly silt (ML) and clay (CL). This transition zone is defined as the B Zone hydrostratigraphic unit.

Lacustrine Deposit (C Zone)

A laterally extensive, massive clay deposit (CL) was identified in samples from most borings. The clay deposit is easily recognized in soil sample cores as lean clay with high plasticity. A sharp contact is observed at both the top and bottom of this deposit. Laboratory analyses indicated that on average the deposit contains 98% silt and clay. The areal distribution pattern indicates that the deposit was formed in ponded water between the bedrock highlands south of the Plains and glacial ice to the north. This deposit is defined as the C Zone hydrostratigraphic unit. The B Zone and C Zone deposits, where present, form a confining unit between the A Zone and D Zone hydrostratigraphic units.

Outwash/Ablation Till (D Zone)

A deeper deposit of coarser-grained material was encountered beneath the C Zone lacustrine deposit. Samples from this deposit are classified as predominantly fine- to medium-grained sand (SP to SM) and are similar to samples of A Zone hydrostratigraphic material. This material appears to be outwash deposited prior to the glacial lake period on the Plains.

Greater heterogeneity in grain size characteristics was observed within the D Zone compared to the A Zone. The finer-grained portion of this formation appears to be an ablation till. This deposit ranges from confined to unconfined where the C Zone and B Zone formations are absent, notably in the area north and east of the TWIS. This deposit is defined as the D Zone hydrostratigraphic unit.

Basal Till (E Zone)

Basal till is glacial material deposited directly from the base of the ice sheet. The material is poorly-sorted and consists of boulder- to sandy-sized clasts in a fine-grained matrix. This is the lowermost Quaternary deposit identified in most borings in the vicinity of the project. In areas more distant from the Eagle Project, this unit is substantially thicker. Bedrock is also encountered at greater depths at these distant locations. The unit appears to be wet to water saturated at locations close to the Project where it is a fairly thin deposit and directly overlies bedrock; but it was found to be dry at locations QAL009 and QAL010 where a significant thickness of basal till is present. This lack of saturation of the basal till is anecdotal evidence of a lack of upward hydraulic gradients from the bedrock to the Quaternary aquifer. This deposit is defined as the E Zone hydrostratigraphic unit.

Lower Outwash Units (F Zone)

At two locations distant from the Eagle Project area (QAL007 and QAL010), lower outwash deposits were found interlayered with E Zone till. Representative samples of the lower outwash material are classified as predominantly fine- to medium-grained sand (SP to SM). In QAL010 these units were dry indicating a lack of saturated flow between the bedrock and Quaternary aquifer. This lower outwash deposit is defined as the F Zone hydrostratigraphic unit.

Stratigraphic Relationships

The relationship between the hydrostratigraphic units is depicted in cross-sectional views as displayed on figures in Appendix B-1 and Appendix B-5. These cross-sections depict the primary water-bearing zones in the area (unconfined A Zone and confined D Zone) that are separated by the fine-grained B Zone transitional deposit and C Zone lacustrine clay unit near the Eagle Project site. The bedrock topographic highs in the area coincide with the Peridotite intrusion that appears to have been an erosionally resistant feature during periods of glaciation.

The B Zone and C Zone fine-grained deposits are laterally extensive across a broad area of the Plains, but pinch out north and east of the site. As a result of the pinch-out of the fine-grained deposits, the A Zone and D Zone become a single, unconfined hydrostratigraphic unit north of the Peridotite outcrop and along the eastern edge of the main surface facility. This is consistent with the depositional model, which suggests that these fine-grained units were formed from a glacial lake created by melt water ponding between the stagnant ice margin at the northern edge of the Plains and the bedrock highland to the south.

The hydraulic conductivity of the glacial deposits has been extensively tested as summarized in Tables in Appendix B-1.

3.4.1.2 Groundwater Occurrence

The Quaternary deposits of glacial alluvium described in Section 3.4.1.1 form the aquifer for the Yellow Dog Plains. The Quaternary deposits possess sufficient hydraulic conductivity and saturated thickness to yield significant quantities of water to wells and or springs to meet the definition of an aquifer in R 425.102(1)(c). Within the Quaternary deposits, groundwater flows towards and discharges into the Salmon Trout River System and Yellow Dog River. However, as described in Appendix B-1 and Appendix B-5 the groundwater basins of the Salmon Trout River and Yellow Dog River do not coincide with the watershed boundaries of these two rivers. Rather the groundwater basin of the Salmon Trout River captures most of the groundwater flow in the Quaternary aquifer of the Yellow Dog Plains. The groundwater divide between the Yellow Dog River and Salmon Trout River lies approximately 6,000 feet (over 1-mile) south of the ore body (see Figures 3-1 and 3-5).

Potentiometric surface maps for the study area (Appendix B-1) display that the pattern of groundwater flow across the plains is predominantly toward the Salmon Trout River System. On a local scale, groundwater discharges to the Salmon Trout River Main Branch. However, on a regional basis, groundwater in the Quaternary aquifer flows north and discharges to: 1) seeps in the north terrace that drain into the Salmon Trout River East Branch; 2) tributaries of the Salmon Trout River East Branch; and 3) the Salmon Trout River East Branch. Additional details on saturated thickness and groundwater elevation measurements are provided in Appendix B-1 and Appendix B-5 including information required under R 425.202(2)(d)(i) – (iii).

As part of the hydrogeologic studies, bedrock piezometers were installed in the immediate vicinity of the ore body (see Appendix B-1 through B-3) to establish water quality and vertical hydraulic gradient profiles in the Precambrian bedrock. Water quality data is discussed in Section 3.4.1.5 below. Vertical hydraulic gradient data indicates there is no pattern of vertical gradient within the bedrock system. This finding is important in that it is consistent with geologic inferences discussed above and confirms that under an unstressed condition, there is no vertical migration of water from the bedrock to the Quaternary aquifer. Water quality data discussed in Section 3.4.1.5 also confirms this conclusion.

3.4.1.3 Surface Water Hydrology

Per R 425.202(2)(e) extensive data were collected on variations in flow in the Salmon Trout River System, Yellow Dog River and Cedar Creek. Monitoring was completed in the Cedar Creek to establish baseline conditions in a surrogate watershed that is not affected by project activities.

Stream flow measurements within the study area began in the fall of 2002. KEMC continues to collect stream flow data on a routine basis and has established a robust data base that captures annual and seasonal variation for a period of time that exceeds three years. KEMC's stream flow measurements have consisted of seasonal measurements at monitoring stations STRM001 – STRM005, STRM007 – STRM009, STRW001, STRE001, STRE002, STRE005, STRE006, STRE009 – STRE014, YDRM001 – YDRM003, CDRA002 and CDRM004. In addition to seasonal measurements, continuous monitoring stations for flow were established at STRM004,

STRM005, STRE002, and YDRM002. Figure 3-1 shows the location of these monitoring stations. Tables in Appendix B-5 summarize stream flow measurements.

3.4.1.4 Hydrologic Budget

A numerical groundwater model of the bedrock and a regional groundwater flow model of the Quaternary system were developed to confirm KEMC's understanding of the hydrogeology at the site and assess potential changes to the water budgets of rivers and wetlands around the project site. The modeling reports are provided in Appendix B. The models were calibrated to site specific conditions based on numerous pump tests, bedrock packer tests and recorded groundwater elevations and stream flows. Appropriate sensitivity analysis was completed. Evapotranspiration is accounted for in the models as the net recharge to the Quaternary aquifer. Project development is not expected to affect evapotranspiration in a manner that could be considered significant, since the project site is in a net precipitation area based on meteorological data from surrounding national weather stations. The calibrated groundwater models coupled with the extensive regional information on groundwater flow and stream flow provide a quantitative baseline set of hydrologic data from which to assess potential impacts to groundwater flow, surface water flow and water quality.

3.4.1.5 Water Quality

Per the requirements of R 425.202(2)(g) sampling of groundwater quality in the study area was completed to establish a water quality database for the following parameters:

- ♦ Specific conductance
- ♦ Temperature
- ♦ pH
- ♦ Dissolved oxygen
- ♦ Concentrations of major cations
- ♦ Concentrations of major anions
- ♦ Concentrations of a broad spectrum on inorganic ions
- ♦ Concentrations of bioaccumulating substances

Water quality sampling began in the fall of 2002 and has been ongoing since that time. The data base that has been established by KEMC is based on both seasonal and continuous monitoring data and surpasses the requirements specified in R 425.202(2)(g) and R 425.202(3).

The following is a summary of the findings based on surface water quality monitoring:

- ♦ Calcium and bicarbonate ions are the principal dissolved constituents in water at all locations monitored. The streams can generally be described as soft (hardness <60 mg/L) to moderately hard (60-120 mg/L) with neutral pH (ranging from weakly acidic to weakly alkaline) with a low degree of mineralization and turbidity. Nutrient concentrations are generally low and dissolved oxygen is generally high.
- ♦ The streams dominated by seepage from the north terrace (Salmon Trout River East Branch) exhibit water quality conditions indicative of higher contributions from groundwater flow. These streams have somewhat higher conductivity values, greater hardness concentrations, warmer winter temperatures and cooler summer temperatures

compared to reaches of streams that are not affected by seepage from the north terrace. The streams at the base of the north terrace also have less color and lower organic carbon content. This finding provides supporting evidence of significant capture of groundwater from the Plains by the Salmon Trout River system, consistent with the results of mapping groundwater flows patterns as depicted on Figures in Appendix B-1.

- ♦ The surface water continuous specific conductance data show the periodic influence of increased surface water contribution associated with snowmelt runoff and from significant precipitation events. Also, increased mercury concentrations occur during periods of increased surface runoff. Mercury concentration appears to be related to regional atmospheric mercury deposition released by surface runoff rather than localized sources of mercury in the watershed. Somewhat higher turbidity and total suspended solids are also detected in streams following snowmelt runoff.
- ♦ Minor and trace constituents detected in most streams include iron, arsenic, barium, manganese and aluminum. Trace concentrations of copper, zinc and cadmium were infrequently detected in samples from a few monitoring locations. Because dissolved iron is a redox sensitive parameter, its concentration also varies seasonally, particularly at locations exhibiting a seasonally wide range of dissolved oxygen concentrations (e.g., STRM001).
- ♦ Surface water monitoring results generally indicate good water quality at all monitoring locations. No bioaccumulating organic substances were detected.

The following is a summary of groundwater quality data collected from the Quaternary deposits and bedrock:

- ♦ Quaternary water quality of most groundwater samples can be generally characterized as low TDS, soft to moderately hard and dominated by calcium and bicarbonate ions. Dissolved oxygen concentrations are generally depleted with depth and dissolved iron and manganese increase in response to this redox condition. Total dissolved solids (TDS) tend to increase with depth. This pattern indicates that shallow water is dominated by precipitation recharge and then becomes mineralized with depth and residence time.
- ♦ Other than the vertical changes in hydrochemistry, there are some local variations found in major, minor and trace constituents at specific monitoring points, but no apparent widespread pattern of hydrochemical facies changes in the Quaternary system. This indicates that there are no distinct or separate source waters for the Quaternary system.
- ♦ Bedrock groundwater is dominated by sodium, potassium and chloride ions, whereas Quaternary deposit groundwater is dominated by calcium and bicarbonate ions. This provides further evidence of poor hydraulic communication between the glacial deposits and bedrock, which is consistent with the results of hydraulic property testing presented in Appendix B-2 and B-3.
- ♦ Analysis of tritium levels in groundwater confirms that the bedrock system is distinct from the Quaternary system.

- ♦ Water quality data in the bedrock is dominated by sodium chloride. The level of TDS increases substantially at an elevation of approximately 335 m MSL, consistent with hydraulic conductivity data and further evidence that the bedrock is not an aquifer and does not interact with the Quaternary aquifer in an unstressed condition.

3.4.2 Evaluation of Potential Groundwater Impacts

The mining operations that could potentially impact groundwater quantity and groundwater quality include the following:

- ♦ A reduction in groundwater levels in the Quaternary aquifer due to dewatering of the mine during operations.
- ♦ An increase in groundwater elevations due to the infiltration of treated water at the TWIS during the operational phase of the Eagle Project.
- ♦ A leak of contact water through the liner system of the CWB.
- ♦ A leak of contact water through the TDRSA liner system.
- ♦ A spill of diesel-fuel or unleaded gasoline associated with the fuel storage and distribution system.
- ♦ The migration of inorganic ions from the backfilled mine up into the Quaternary aquifer.

Each of these potential impacts are evaluated in Sections 3.4.2.1 through 3.4.2.2.4. Each of the potential impacts are assessed with respect to the plans for the project including:

- ♦ Proposed engineering controls.
- ♦ Proposed monitoring plans for the operational and post-closure periods.
- ♦ Contingency response plans.
- ♦ Regulatory response requirements contained in R 425.406.
- ♦ KEMC's financial assurance for project reclamation and environmental contingencies.

3.4.2.1 Changes in Groundwater Elevation and Flow

As documented in Appendix B-1 and the supporting groundwater modeling results in Appendices B-4 and B-7, groundwater inflow to the underground mine is estimated to be approximately 75 gpm. This inflow rate is based on measured bedrock hydraulic conductivity and the numerical groundwater model of the bedrock system. Recognizing that there is a degree of uncertainty in measuring the hydraulic conductivity of the bedrock, an upper range of hydraulic conductivity values was estimated and incorporated into the bedrock model to provide an upper bound estimate of groundwater inflow to the mine. This upper bound inflow simulation indicates that the maximum potential inflow of groundwater to the mine is approximately 215 gpm. Both the expected case and upper bound estimates of inflow, to the mine are small manageable amounts of water to remove from the mine and treat.

To estimate groundwater elevation changes due to mine dewatering and infiltration of treated water, the groundwater model of the Quaternary aquifer and associated river systems was

employed (see Appendices B-1 and B-7). To simulate mine operations, the model of the Quaternary aquifer was modified to represent the groundwater inflow predicted by the bedrock model. The expected case and upper bound predicted drawdown around the mine and mounding around the TWIS are displayed in Figures in Appendix B-1 and Appendix B-7. The potential groundwater flow patterns are also provided in Figures in Appendix B-1 and Appendix B-7.

In reviewing the predicted changes in groundwater elevation and flow the following is noted:

- ♦ For the expected case, with inflow at 75 gpm, no drawdown of the water table greater than 0.5-ft is predicted.
- ♦ For the upper bound estimate of 215 gpm inflow, the area of predicted change in groundwater elevation is limited to a small area around the mine. As determined by the 0.5-ft drawdown contour, this encompasses an area less than a 1/3-mile radius around the mine site.
- ♦ The groundwater mound around the TWIS creates a local reversal in horizontal hydraulic gradients. However, on a regional scale, groundwater flow from the TWIS and the main surface facility remains in a north-northeastern direction toward the groundwater seeps along the north terrace and tributaries of the Salmon Trout River East Branch.
- ♦ Groundwater elevation changes are entirely within the groundwater basins that drain to the Salmon Trout River Main Branch and East Branch.
- ♦ There are no groundwater elevation changes within the groundwater basin of the Yellow Dog River.

The assessment of the changes in groundwater elevation and flow with respect to cumulative impacts on surface water flow, aquatic biota, wetland vegetation and functions, and a state-listed species that is present in wetland communities is provided later in this EIA.

3.4.2.2 Potential Groundwater Quality Impacts During Operations

During operations there are three potential mechanisms by which groundwater quality could be affected as described above. Each of these mechanisms are addressed in Sections 3.4.2.2.1 through 3.4.2.2.4.

3.4.2.2.1 Groundwater Quality Impacts Due to Liner System Failure

As described in Section 4 of Volume I of this *Mining Permit Application*, the liner systems of the TDRSA and CWBs are designed and constructed so that they do not leak. A breach in the liner due to a manufacturer defect in the geomembrane, installation defect of the geomembrane or a tear in the liner during operations is unlikely but possible. To minimize the potential for leakage, the liner systems of the TDRSA and CWBs will be installed in accordance with a Construction Quality Assurance (CQA) program that includes testing of the liner materials and leak detection surveys prior to operating the CWBs and TDRSA.

To assess the potential for leakage, a secondary collection system will be installed beneath the sump of the TDRSA. This secondary collection system will be monitored to confirm that no

leakage is taking place beneath the TDRSA. If leakage through the sump were to occur, the development rock in the vicinity of the sump would be removed to access and repair the liner in the sump.

In accordance with the monitoring plan provided in Volume I of this *Mining Permit Application*, groundwater monitoring wells will be placed around the TDRSA and CWBs to monitor potential impacts to groundwater quality due to potential leakage from the CWBs and TDRSA liners. In the event that actionable levels of contaminants are measured in wells, the response action steps specified R425.406 will be followed. Remediation of deleteriously impacted groundwater will include pumping groundwater out of the affected area(s) and treatment at the WWTP. Since the CWBs and TDRSA are relatively small facilities and leaks from geomembrane liner systems are confined to relatively small areas, the volume of groundwater that would require remediation is expected to be relatively small and easily handled by the WWTP and TWIS. For the same reasons, the duration of groundwater remediation would be easily addressed within the time frame of project operations and post-closure care.

An additional layer of environmental protection is provided by the financial assurance KEMC will provide, which accounts for environmental contingencies.

For all of the reasons stated above, groundwater quality impacts due to potential leakage from the CWBs and TDRSA are expected to be non-existent at the end of the 20-year post-closure monitoring period.

3.4.2.2.2 Groundwater Quality Impacts due to Failure of the WWTP

A second mechanism by which groundwater quality could be affected is through failure of the WWTP. This possibility is considered extremely remote. As described in the *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006), the performance of the WWTP will be closely monitored and any upset in the treatment process will result in effluent from the WWTP being routed back to the CWBs. The CWBs have ample reserve storage capacity since they have been sized to handle conditions in which the WWTP is down for several weeks. In addition, the contingency plan calls for additional back-up storage in the TDRSA on an emergency basis. Based on the system performance monitoring and back-up storage in the CWBs and TDRSA, untreated water will not be discharged to the TWIS and subsurface either by necessity or from undetected system failure.

3.4.2.2.3 Groundwater Quality Impacts Due to the Reclaimed Mine

Reclamation of the underground mine workings is designed to protect groundwater quality in the Quaternary aquifer.

Bedrock hydrogeologic characterization data documented in Appendix B-3 demonstrates that there is no measurable pattern of vertical hydraulic gradient in bedrock around the Eagle deposit. Moreover, groundwater within the bedrock transitions to a saline water at about 335 m MSL or just below the upper two mining levels (see Figure 3-6). Overall the data demonstrates that under an unstressed condition the water in the bedrock system does not affect water quality on the Quaternary aquifer.

By sealing the vertical connections in the mine workings to isolate the lower levels below the saline/non-saline transition in the bedrock, the lower regions of the mine (which constitute approximately 80 percent of the mine workings) will be physically isolated, and vertical migration routes of saline water within the mine workings will be eliminated. This plan will promote the re-establishment of pre-mining patterns of vertical hydraulic gradient.

To further promote the long term groundwater quality protection goals of the project, the mine reflooding process will be accelerated by pumping groundwater obtained from the project's potable well or other water well installed on KEMC property. This will cut off exposure of the underground mine to atmospheric oxygen that can cause oxidation of the residual surface minerals. Finally, groundwater quality in the reclaimed upper mine workings and bedrock vertical gradients will be monitored. In the event that monitoring data indicate the potential for groundwater quality impacts in the Quaternary aquifer, the contingency plan for the reclaimed mine will be implemented. The contingency plan for the mine workings calls for the withdrawal of water from the workings, treatment at the WWTP, and flushing the treated water through the workings in a closed loop fashion. This flushing process would continue until water quality in the workings of the upper two levels improves to the point where it is no longer a threat to water quality in the Quaternary aquifer. As described in Volume I of this *Mining Permit Application*, this is not a perpetual case contingency.

For the reasons stated above, groundwater quality impacts due to the reclaimed underground mine are expected to be non-existent at the end of the 20-year post-reclamation period and beyond.

3.4.2.2.4 Groundwater Quality Impacts Due to Fuel Spillage

Groundwater quality impacts due to leaks or spillage of diesel-fuel or gasoline are considered unlikely. As described in Volume I of this *Mining Permit Application*, KEMC will have on file a comprehensive SPCC Plan and PIPP (as applicable) that will address response actions in the event of fuel spills, leaks and releases. In addition the fuel storage area will be constructed with a secondary contamination system. The containment system and response plans will be followed during operations and by regulatory design are intended to prevent groundwater contamination.

In the unlikely event that fuel spills, leaks or releases occur, the impacted unconsolidated materials will be excavated and disposed of per regulatory requirements. Any groundwater that is impacted would be treated on-site through readily available treatment systems designed to treat petroleum related contaminants.

For the reasons stated above, groundwater quality impacts due to potential spills or leaks of diesel-fuel or gasoline are expected to be non-existent at the end of the 20-year post-closure period.

3.4.3 Evaluation of Potential Surface Water Impacts

The mining operations that could potentially impact surface water quantity and quality include the following:

- ♦ Mine dewatering induced drawdown of groundwater in the Quaternary aquifer could potentially reduce the amount of groundwater discharging to area streams thereby reducing water levels and the amount of flow in the streams.
- ♦ Changes in the volume of storm water runoff to the streams due to surface facility operations.
- ♦ Changes in the amount of groundwater flow to area streams due to the infiltration of treated water at the TWIS.
- ♦ Surface water quality impacts caused by runoff from the surface facilities.
- ♦ Surface water quality impacts due to operation of the TWIS.
- ♦ Surface water quality impacts due to leakage from the CWBs, TDRSA.
- ♦ Surface water quality impacts due to spills and leakage of diesel-fuel and gasoline.
- ♦ Surface water quality impacts caused by the reclaimed underground mine.

Each of these potential cumulative impacts is evaluated in the context of the probability of it occurring and the operational engineering controls, monitoring plans, contingency plans and financial assurance provided in Volume I of this *Mining Permit Application*.

3.4.3.1 Potential Changes in Stream Flow

The regional groundwater model of the Quaternary system (see Appendix B-7) was used to assess potential changes in stream flow. Changes in stream flow could occur due to mine dewatering induced drawdown of groundwater in the Quaternary aquifer. Additional changes in stream flow could occur due to the TWIS. Table 3-1 and 3-2 summarize changes in stream flow and elevation at surface water monitoring stations STRM002, STRM004, STRM005, STRE002, STRW001 and YDRM002 displayed on Figure 3-1. The predicted changes in flow are less than a tenth (0.1) of a cubic feet per second (cfs) at the various flow monitoring stations. These predicted changes are within the measurement error of streamflow for natural systems and this change could not be detected in the environment especially when one considers the range of seasonal variation. On a percentage basis, the change in stream flow is typically less than a maximum of three percent of measured ranges of baseline flow. At station STRM002 (located on the Salmon Trout River Main Branch near the underground mine) there will be no change in stream under expected case conditions. Upper bound estimates of changes in stream flow at STRM002 show a decrease of about 1.8 percent of the minimum flow. For several monitoring stations the flow is actually predicted to increase slightly (a net increase of less than three percent) due to the TWIS. Overall, the area of theoretical potential affect is limited to the Salmon Trout River Main Branch south of Triple A Road. Furthermore, the area of theoretical potential affect does not extend to the Yellow Dog River or the Salmon Trout River below the confluence of the East, Main and West Branches. In general, the modeled changes in flow and stage presented in Table 3-1 and 3-2 represent numeric model precision that cannot be measured in these natural systems.

As documented in Appendix B-1, the predicted changes in stream flow are for an advanced stage of mining at the end of operations which assume the entire mine area is open and not backfilled. Thus these already small predicted changes in stream flow for the upper bound conditions are conservative and will only occur the end of mining.

Appendix B-1 and Appendix B-7 provides a chart depicting the source of the groundwater flowing into the mine. Initially, at the start of mining, groundwater flowing into the mine is derived from storage in the bedrock and Quaternary aquifers. As the groundwater level in the aquifer is lowered, the inflow to the mine slowly begins to be derived from groundwater that would normally discharge to streams such as the Salmon Trout River Main Branch. However, since the mine is short lived and the inflow rates are relatively low, a significant portion of the inflow water at the end of mining continues to come from aquifer storage. Aquifer storage acts to attenuate the mine dewatering impacts to the streams, particularly the Salmon Trout River Main Branch south of the Triple A Road.

Table 3-1
Summary of Potential Changes in Stream Flow
at Key Monitoring Stations within Eagle Project Study Area

Monitoring Location	Measured Rand of Flow from Baseline Studies			Predicted Changes in Flow							
				Expected Case				Upper Bound Case			
				Change in Flow (cfs)	Percent Change Relative to:			Changes in Flow (cfs)	Percent Changes Relative to:		
					Max.	Min.	Ave.		Max.	Min.	Ave.
STRM002	2.3	5.3	0.9	0	0	0	0	-0.016	-0.30	-1.8	-0.7
STRM004	6.7	41	4.2	0.003	0	0.1	0	0.004	0.01	0.1	0.1
STRM005	44	397	22	0.23	0.1	1.0	0.5	0.32	0.01	1.5	0.7
STRE002	21	119	12	0.23	0.2	1.9	1.1	0.32	0.30	2.6	1.5
YDRM002	28	242	6.5	0.026	0.01	0.4	0.1	0.048	0.02	0.7	0.2

Prepared by: SVD1
Checked by: LJS

Table 3-2
Summary of Potential Changes in Stream Levels
at Key Monitoring Stations within Eagle Project Study Area

Monitoring Location	Expected Case		Upper Bound Case	
	Change in Flow (cfs)	Change in Depth @ Min Flow (ft)	Change in Flow (cfs)	Changes in Depth @ Min Flow (ft)
STRM002	0	0	-0.016	-0.01
STRM004	0.003	<0.01	0.004	<0.01
STRM005	0.23	<0.01	0.32	0.01
STRE002	0.23	<0.01	0.32	0.01
YDRM002	0.026	<0.01	0.048	<0.01

Prepared by: SVD1
Checked by: LJS

3.4.3.2 Potential Changes in Runoff to Area Streams

The main surface facility and the backfill facility comprise approximately 92-acres of land that will be disturbed as part of site construction. Storm water management plans described in Volume I of this *Mining Permit Application* layout plans for managing and treating all storm water runoff on-site. Storm water runoff from the main operations area will be routed to the CWBs for storage followed by treatment and discharge by the WWTP and TWIS. Storm water runoff from the non-contact areas of the site will be routed to NCWIBs where sediments will be retained and the runoff water will infiltrate back to the groundwater surface. By managing all runoff water on site, there will be a very slight reduction in runoff to areas south of the surface facilities.

As documented in Figures 3-1 and 3-2, surface facilities reside primarily in the watersheds of the Salmon Trout River Main Branch. Although the access road area of the main surface facility is within the margins of the Yellow Dog River watershed this theoretical alteration of drainage is too remote from the Yellow Dog River to affect surface runoff to the river.

Similarly, the watershed of the Salmon Trout River Main Branch is approximately 5,632 acres. The temporary removal of approximately 78 acres of surface facility area from the watershed of the Salmon Trout River Main Branch will lead to an immeasurable change in natural runoff to this stream.

3.4.3.3 Potential Impacts on Surface Water Quality from Storm Water Runoff

As described above in Section 3.4.3.2, storm water runoff from the surface facilities will be managed on-site. The potential for runoff from the main operations area impacting water quality in streams such as the Salmon Trout River Main Branch is considered non-existent. All storm water runoff from the operations area will be routed to the CWBs. The TDRSA and underground mine provide additional storage capacity per the contingency plan in Volume I of this *Mining Permit Application*. As such, water quality impacts to the Salmon Trout River attributed to runoff from the main operations area are not a reasonable impact scenario.

The NCWIBs will be designed with an outlet structure for peak runoff events that exceed a 50-year event due to combined snowmelt and precipitation (exceeds 100-yr, 24-hr precipitation event). The release of storm water from the NCWIBs will be permitted under the MDEQ storm water management permit program. The NCWIBs are designed to settle suspended sediments. In the event of a release, storm water would not carry a sediment load that will affect surface water quality.

3.4.3.4 Potential Surface Water Quality Impacts from the TWIS

The TWIS is located in the groundwater basin of the Salmon Trout River East Branch (see Appendix B-1). It is highly unlikely that the TWIS will affect water quality in the Salmon Trout River East Branch. In order for that to occur, the discharge of untreated or partially treated wastewater from the WWTP to the TWIS would need to occur. As described in Section 3.4.2.2.2 above, this is unlikely. In the event this did occur, groundwater monitoring at the TWIS would likely detect the release triggering a remedial response at the TWIS before the impacted groundwater could migrate over a mile to the Salmon Trout River East Branch. Thus in order for the water quality in the Salmon Trout River East Branch to be affected in a

measurable way by the TWIS, there would need to be a complete failure in the WWTP and TWIS monitoring system over an extended period of time (years). This will not happen for the reasons stated above. Thus potential measurable effects on water quality in the Salmon Trout River East Branch are not a reasonable impact hypothesis.

As described in the *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006) an advection dispersion model was used to assess the potential impact on mercury concentrations in the Salmon Trout River East Branch due to the discharge of treated water at the TWIS. The concentration of mercury in the effluent from the WWTP is estimated to be about 2 ng/l. By way of comparison, background levels of mercury in the Salmon Trout River East Branch have been measured as high as about 4 ng/l (Appendix B-5). After treated water is infiltrated into the aquifer and flows approximately 4,500 ft to the tributaries of the Salmon Trout River East Branch, the potential for a measurable change in background mercury concentrations in the groundwater is at best at the molecular level and immeasurable in nature. Therefore there will not be measurable effect on background mercury levels in the Salmon Trout River East Branch.

3.4.3.5 Impacts to Surface Water Quality from Spills

In order for surface water quality to be impacted by spills and leaks of diesel-fuel and gasoline, the spill or leak from the mine area would need to impact groundwater that would eventually discharge to the Salmon Trout River Main Branch or East Branch. As described in Sections 3.4.2.2.4. KEMC's SPCC Plan and PIPP provide response actions for spills and leaks to remove impacted soil and remediate impacted groundwater. Surface water quality impairment from spills and leaks of diesel fuel and gasoline would require a complete failure to comply with the SPCC Plan and PIPP requirements. Thus surface water quality impairment due to spills and leaks of petroleum products is considered as a scenario that is not reasonably likely.

3.4.3.6 Impacts to Surface Water Quality from the Reclaimed Mine

The mechanism by which the water in the reclaimed mine impacts surface water quality in the Salmon Trout River Main Branch is as follows:

- ♦ Water in the mine workings in the upper two mine levels would need to migrate through the bedrock, into the Quaternary aquifer through the aquitard of fine grained sediments and then into the Salmon Trout River Main Branch.

As described in Volume I of this *Mining Permit Application*, the reclamation plan includes provisions to minimize the potential for upward migration of contaminants from the mine. Moreover, measured hydraulic gradients within the bedrock show that there is no appreciable upward flow from the bedrock to the Quaternary aquifer. By sealing vertical connections in the mine, these vertical hydraulic gradient patterns will be reestablished. The monitoring plan calls for monitoring to be completed in and around the mine during the post-closure period to detect at an early stage the potential for impacts on groundwater quality. If monitoring data indicates that water quality in the Quaternary aquifer could be impaired by the reclaimed mine, contingency plans (see Volume I of this *Mining Permit Application*) will be implemented to remove contaminants from the upper mine workings and prevent the impairment of water quality in the Quaternary aquifer.

By focusing the contingency plan for the reclaimed underground mine workings on protection of water quality in the Quaternary aquifer, water quality in the Salmon Trout River will also be protected.

Finally, KEMC's financial assurance includes funds for environmental monitoring, reclamation of the underground mine, and environmental contingencies. Based on this, and all the reasons cited above, it is expected that there will be no impacts to water quality in the Salmon Trout River Main Branch from the reclaimed mine during operations or after reclamation.

3.4.4 Subsidence

The underground mine needs to provide stable rock mass conditions during operations and after reclamation. The layout and dimensions of the mine workings and backfill plans for the mined out stopes are all designed to provide stable rock mass conditions and to prevent measurable surface subsidence. The analysis that documents rock mass stability and the fact that subsidence at the land surface will not be measurable is provided in Volume I of this *Mining Permit Application*.

3.5 Water Supply and Part 201 Facilities

Per R 425.202(2)(h)-(l) MDEQ and Marquette County water well construction records were reviewed for the location of domestic wells within an approximate 75 square mile area around the Eagle Project site. Data on the record searches are provided in Appendix B-10.

3.5.1 Existing Public, Private and Irrigation Wells

There are no recorded public, private or irrigation wells in the area of potential groundwater drawdown. The nearest well is located about 1-mile northwest of the ore body, outside the area of groundwater drawdown.

3.5.2 Designated Well Head Protection Areas

The Powell Township well, located near Big Bay, and approximately 9 miles northeast of the project site, is the nearest wellhead protection area and is located in a different watershed. The next closest well head protection area is the Ishpeming/Negaunee well head protection area located approximately 20 miles southeast of the project site and also in a different watershed.

3.5.3 Proposed Mining Activities Affecting Wells

The proposed mining activities will not affect public, private or irrigation wells or wellhead protection areas since there are none of these systems or areas within the area affected by mine dewatering.

3.5.4 Part 201 Facilities

There are no sites within the area of groundwater drawdown that are a facility as defined in Part 201 of NREPA.

3.6 Wetlands and Flood Plains

This section of the EIA addresses the requirements of R 425.202(2)(m). The study area for wetland characterization encompassed approximately 1,360 acres around the Eagle Project site and extended beyond the area of potential affect as defined by project facility boundaries and the area of potential groundwater drawdown. The characterization of wetlands was completed by Wetland and Coastal Resources, Inc (WCR). The characterization of wetlands began with a review of United States Fish and Wildlife Service National Wetland Inventory maps and United States Department of Agriculture Soil Survey information for Marquette County. In the Spring and Summer of 2004, WCR delineated wetlands in the immediate vicinity of the Eagle Project site. In the Fall of 2005, WCR reconfirmed the boundaries of selected wetland areas around the Salmon Trout River Main Branch south of the Triple A Road and completed MDEQ wetland data forms. The WCR reports on wetland delineation are provided in Appendix D.

3.6.1 Regional Wetlands

Regional wetlands as obtained from the U.S. Fish and Wildlife Service Wetland Inventory Maps are displayed in Figure 3-7. As displayed on Figure 3-7, the vast majority of wetland acreage on a regional scale resides south of the project site, within the Yellow Dog watershed and outside of the area affected by surface facility construction and mine dewatering (see Section 3.2 and 3.4). As such, there will be no impacts to regional wetland systems. For this reason the wetland studies and impact assessment focused on detailed characterization and assessment of the wetlands within the 1,360 acre study area described in Appendix D-1.

3.6.2 Wetlands in the Vicinity of the Mine Site

Wetlands within the vicinity of the Eagle Project surface facilities and the underground mine were the subject of a detailed evaluation for wetland vegetation, soils, boundaries and hydrology during studies that were completed in 2004 and 2005 and are provided in Appendix B-6 and Appendix D. These wetlands were targeted for these detailed studies to:

- ♦ Verify that facilities will not be sited within regulated wetlands.
- ♦ Document the vegetative communities and hydrology in wetlands that could potentially experience indirect impacts due to changes in hydrology caused by mine dewatering and operation of surface facilities.

Figure 3-8 displays wetland areas that were mapped by WCR in 2004 and 2005. Twenty-six separate wetland complexes were identified by WCR. A detailed description of each wetland complex is provided in Appendix D-1 including the types of wetlands present in each complex and a list of the vegetation identified in each complex. Figure 3-8 displays the WCR mapped wetlands around the Eagle Project.

3.6.2.1 Wetland Hydrology

In 2005 North Jackson Company, Inc. (NJC) completed a study on the hydrology of wetland complex 6. This wetland was selected for detailed hydrologic characterization since it resides directly over the ore body and the area that could be affected by mine dewatering (see Section 3.4.2.1).

As part of the study, NJC installed piezometers at multiple locations and depths within and around wetland complex 6. Groundwater levels within these piezometers were monitored to establish vertical hydraulic gradients within the wetlands. Hydraulic conductivity tests were also completed to assess the hydraulic characteristics of the shallow wetland soils. Water quality samples were collected to assess mineral content of the groundwater in various regions of wetland complex 6.

Based on the hydrological data presented in Appendix B-6 there are two distinct hydrological zones containing wetlands that overlie the ore body that can be distinguished on the basis of hydrological data and groundwater chemistry data. These are: 1) ombrotrophic wetlands supported primarily by precipitation and created in small topographic depressions (natural and disturbed) by slow vertical drainage of precipitation recharge due to near surface, low permeability fine-grained deposits, and 2) slightly minerotrophic wetlands supported primarily by groundwater discharge and created by the topographic intersection with the regional water table. The boundary between these two wetland types (precipitation supported wetland and groundwater supported wetland) directly above the ore body appears to be contiguous as displayed in Figure 3-9.

A third wetland category is found along a narrow linear strip paralleling the Salmon Trout River Main Branch. This wetland area is dominated by stream processes and is supported by water levels in the Salmon Trout River Main Branch. However, because the Salmon Trout River Main Branch is primarily a groundwater supported system (rather than receiving a high degree of surface runoff), its water quality characteristics are also slightly minerotrophic and similar to shallow groundwater in the area. The hydrology of the stream supported wetland areas are controlled by the river level which is strongly affected by beaver ponds in this area.

For precipitation supported wetlands on the valley terraces and slopes, direct precipitation, and shallow groundwater flow provide most of the hydrologic support to the wetlands in wetland complex 6. This view is further supported by several studies. In their text, Ward and Trimble (2004) describe the process of forested hillslope hydrology as follows:

In forest soils, hydraulic conductivity is not uniform in direction. Leaves fall with their long axes parallel to the ground, and more area is covered in roots spreading radially from trees, again, parallel to the ground, so the hydraulic conductivity in a direction parallel to the ground surface is greater than in a direction perpendicular to the ground. This is a condition called soil anisotropy.

Anisotropy can also be created where a soil parent material with relatively low hydraulic conductivity underlies a parent material with higher conductivity. Water infiltrates the more permeable layer of soil until it strikes the less permeable layer, then runs downslope along the interface of the two layers. This condition appears to be present within wetland complex 6.

Because precipitation exceeds evapotranspiration, forested soils in northern Michigan tend to be leached due to a process called eluviation (Fanning and Fanning, 1989). Eluviation occurs when fine weathering products such as iron and aluminum oxy-hydroxides, silt, and clay are washed from the soil "A" horizon to form an iron and aluminum-rich "B" horizon below. As the A horizon continues to be leached, a sandy, ashen "E" horizon is formed. This sandy horizon has

higher hydraulic conductivity than the underlying B horizon. Through this process, soil anisotropy is created by soil horizon development.

The overall effect of the processes described above is to cause the hillslope to drain slowly through “subsurface lateral flow” (Dunne and Leopold, 1978). Subsurface lateral flow is slower than surface runoff on a similar slope and may create saturated soil conditions for time durations long enough to create anaerobic conditions in the soil and support wetland vegetation.

When subsurface drainage pathways coalesce near the ground surface in a process called “return flow” (Dunne and Leopold, 1978), seeps are created. It should be noted, however, that these seeps do not originate from deep groundwater, but, rather, are features of shallow hillslope hydrology.

As such, the hydrology in the precipitation supported wetlands (see Figure 3-9) found along the Salmon Trout River Main Branch is predominantly driven by surface and near surface soil hydrology processes with little communication with deep groundwater.

As previously discussed, the wetland hydrology in the sedge marshes in and adjacent to the Salmon Trout River bed is controlled by the river level, which at this time appears to be determined by the elevation of multiple beaver dams. In between the stream and precipitation supported areas of wetland complex 6 is a narrow strip of wetland that is moderately influenced by groundwater. Of the three hydrologic areas of wetland complex 6, the groundwater influenced region is the most susceptible area to impact by groundwater elevation changes due to mine dewatering. The stream supported region of wetland complex 6 is moderately susceptible to groundwater drawdown due to reduced flow in the stream and associated changes in the water elevation in the stream. The precipitation controlled areas of wetland complex 6 will not be affected by groundwater level changes. Moreover since there are no measurable changes in runoff to wetland complex 6, there is no mechanism for these wetland areas to be affected by mine operations. As such the impact analysis discussed below is focused primarily on the groundwater and stream supported areas of wetland complex 6.

3.6.3 Potential Impacts to Wetland

Construction activities for the Eagle Project will take place in upland areas and will not directly disturb any wetlands. Thus the only mechanism for wetlands to be affected by mining operations is by a mining induced change of a wetland hydrology resulting in a vegetative change in the wetland. Based on data presented in Section 3.4.2.1 and 3.6.2.1 the only wetland area that could potentially be affected is primarily the groundwater influenced region of wetland complex 6 and secondarily the stream controlled region of wetland complex 6. The likelihood of a change in vegetative community structure within these areas will be controlled by the magnitude of the potential hydrologic change and vegetative community characteristics.

To assess the potential impact to wetlands near the proposed mine, it is necessary to consider the water budget of the wetlands in question. According to Brinson’s (1993) hydrogeomorphic model (HGM), components of wetland water budgets can be summarized as follows:

$$dS = PR + Si + GWi + Nci - ET - So - Gwo - Nco \text{ where}$$

dS = change in wetland storage,
 PR = precipitation,
 Si = stream inflow,
 Gwi = groundwater inflow,
 Nci = non-channelized surface water inflow,
 ET = evapotranspiration,
 So = stream outflow,
 Gwo = groundwater outflow
 Nco = Non-channelized surface water outflow

Annual precipitation reported for Marquette County averages 36.32 inches (Marquette County, 2005). For Houghton Michigan, which like the project site is in the Lake Superior snow belt, average precipitation is approximately 33 inches (National Weather Service, Houghton, Michigan). Annual lake evaporation, which is a good surrogate for potential evapotranspiration from a wetland (Ward and Trimble, 2004) is about 24-inches per year (Kohler et al., 1959; Ward and Trimble, 2004). Hence, precipitation exceeds evapotranspiration by about 9-inches to 12-inches per year. Note that Brinson (1993) defines precipitation supported wetlands as surface water supported wetlands, groundwater supported wetlands as groundwater slope wetlands, and stream supported wetlands as riverine wetlands. The following discussion retains the terminology presented in Appendix B-6.

The precipitation supported wetlands receive most of their water from precipitation (PR) and non-channelized surface inflow (Nci). Water losses vary among the wetlands due to variations in topography and soils, but generally the precipitation supported wetlands lose water through evapotranspiration, non-channelized outflow, and groundwater outflow (recharge). Given that:

- ♦ a surplus of precipitation exists at the site,
- ♦ that these wetlands are precipitation supported, and
- ♦ are topographically higher than the regional water table, any changes in the groundwater regime caused by mine dewatering are not expected to have any significant impact on these wetlands.

Stream supported fringe wetlands found next to the Salmon Trout River are supported primarily by the river water, i.e., their water budget is dominated by stream inflow (Si) and stream outflow (So). During periods of low flow, these wetlands are further supported by precipitation (PR), non-channelized runoff (Nci) and groundwater inflow (Gwi).

Soils and sediments in the stream supported wetlands are fine textured organic mucks and silts. Fine textured soils exhibit a “capillary fringe” of saturated soil pores that rises above the static water level, which in this case is the river elevation. The rise in capillary fringe in soils is inversely related to grain size, and for silty soils, vertical rise can be upwards of four-feet. The expected drop in river elevation due to mine dewatering is expected to be de minimus (see Appendix B-1) and is within the natural variation and thus will not affect stream supported wetlands in terms of water supply or water quality.

Groundwater supported slope wetlands found between the precipitation supported wetlands and stream supported wetlands appear to have more complex hydrologic budgets compared to the other two categories, due to variations in topography and soils. The wetland hydrology study (Appendix B-6) demonstrated groundwater inflow (Gwi), however these wetlands certainly receive additional inputs from direct precipitation (Pr) and non-channelized inflow (Nci).

Under existing conditions it is reasonable to expect that during times when a groundwater supported wetland is saturated and or inundated to capacity due to groundwater inflow, any additional precipitation or non-channelized inflow reaching the wetland would not add additional water volume to that wetland and would flow away from the wetland toward the river. In the event that groundwater inflow decreased due to mine dewatering, precipitation and non-channelized surface inflow would be available to make up the potential water deficit within the wetland.

In summary, three natural mitigating factors will compensate for potential wetland hydrology changes due to groundwater losses. They are:

- ◆ Precipitation exceeds evapotranspiration by approximately 12 inches per year. Excess storm runoff and snow melt runoff is available to recharge wetland hydrology.
- ◆ Fine textured soils underlying sand observed in wetland complex 6 strongly suggest that shallow soil hydrology characterized by subsurface lateral flow, as opposed to upward inflow of deep groundwater, dominates wetland hydrology in groundwater supported wetlands.
- ◆ Capillary rise in fine textured soils, which may be as high as several feet vertically, will tend to keep many wetland soils saturated despite the anticipated proposed drawdown in the regional groundwater table and slight decreases river level.

As documented in Appendix B-1, natural groundwater fluctuations within the wetlands are about 0.5 ft. As such, the limit of measurable drawdown is about 0.5 ft. For the expected case conditions, drawdown of the water table in the vicinity of the mine will be less than 0.5 ft. Thus there are no wetlands that could be potentially affected by mine dewatering under expected case conditions. The potentially affected wetland areas under upper bound estimates of groundwater drawdown is displayed in Figure 3-10 and represents between 0.6 and 0.7 percent of the total wetland area in the Salmon Trout River watershed. Table 3-3 and 3-4 summarize potentially affected wetland areas related to regional wetland acreage for the expected case and upper bound inflow conditions.

In the event that the natural mitigating factors are not as effective at minimizing impacts to wetland hydrology, potential mine dewatering impacts on wetlands would result in a shift in the wetland plant communities from species that are more saturation tolerant to species that are less tolerant of saturated soil conditions. Because Wetland Complex 6 is a wetland-upland complex, there are both groups of plant species in close proximity of one another. Upland species, under dryer soil conditions, would grow from seeds already present in the soil or spread rhizomatously from dryer to former wetland positions. The former wetlands would remain vegetated, mostly forested, and continue to function as natural wildlife habitat within the larger wetland-upland

complex that extends along the Salmon Trout River Valley. Following mining and reclamation, the affected vegetated areas would revert to the pre-mine hydrologic conditions, with the corresponding reversal in plant communities favoring hydrophytic species.

Table 3-3
Wetland Areas Within the 0.5-ft
Drawdown Area – Expected Case Inflow

Wetland Hydrologic Type	0.5-ft Drawdown Area (acres)
Precipitation Supported	0
Groundwater Supported	0
Stream Supported	0

Note: Total wetland acreage in Salmon Trout River watershed equals to 2,945 acres based on NWI or 3,205 acres based on MIRIS.

Prepared by: SVD1
Checked by: DAT

Table 3-4
Wetland Areas Within the 0.5-ft
Drawdown Area – Upper Bound Inflow

Wetland Hydrologic Type	0.5-ft Drawdown Area (acres)
Precipitation Supported	14.39
Groundwater Supported	4.99
Stream Supported	0.34

Note: Total wetland acreage in Salmon Trout River watershed equals to 2,945 acres based on NWI or 3,205 acres based on MIRIS.

Prepared by: SVD1
Checked by: DAT

3.6.4 Potential Impacts to Floodplains

The nearest floodplain to the project site occurs within the lowland areas around the Salmon Trout River Main Branch. There are no construction or other operational activities associated with the Eagle Project that will change or affect the floodplains of the Salmon Trout River system.

3.7 Terrestrial Biology – Upland Habitat, Ecosystems and Wildlife

This section of the EIA addresses the requirements of R 425.202(2)(z) and (dd). WCR completed a detailed assessment of wildlife species and habitat. The first step in the assessment was the review of available wildlife and habitat data from the United States Department of Agriculture, the Michigan Department of Environmental Quality, Whitefish Point Bird Observatory, United States Fish and Wildlife Services, and National Wetland Inventory maps. Site specific assessments were conducted as well. Specifically, the WCR reports on habitat

mapping and wildlife species assessment are provided in Appendix E and Appendix F. As part of the habitat mapping work, a plant inventory of the area around the project site was completed and a complete list of vascular species observed was prepared. The study that was completed meets the requirements of R 425.202(2)(y) in that literature sources based on prior studies were used as part of the assessment which also includes one year of site specific data collection. The study area encompassed approximately 1,300 acres around the project site.

3.7.1 Ecosystems and Wildlife and Potential Impacts

Figure 3-12 displays the mapped habitats and wildlife sampling transects and stations as well as frog sampling stations. A description of each habitat area is provided in Appendix F-1. Aside from potential impacts to wetland vegetative communities (discussed in Section 3.6) potential impacts to terrestrial habitats and wildlife are limited to areas of the project site where surface facilities will be constructed. This includes the backfill facility and main surface facility. The backfill facility is located near the east end of the ore body, south of Triple A Road. The main surface facility is located in the northeast portion of the study area. WCR identified four habitat types within those areas: C1, C2, D, and G.

Habitat type C is an upland woodland habitat area with two distinct sub-habitats, one dominated by coniferous tree species (C1) and the other with a mix of deciduous and coniferous tree species (C2). There are few signs of reforestation, suggesting that the area has naturally regenerated from historical logging.

Habitat type C1 is defined by WCR as an “upland woodland habitat” with a dominant coniferous tree community of jack pine, red pine, and white pine. Approximately 10% of the forest community is comprised of deciduous tree species. The C1 habitat type is common in the eastern portion of the study area.

Habitat type C2 is also defined by WCR as “upland woodland habitat” with a mix of deciduous and coniferous tree species. Type C2 is dominated by red maple, jack pine, paper birch, beaked hazelnut, and choke cherry. The C2 habitat type is common in the central and western portion of the study area.

Habitat type D is an upland forest community dominated by pine trees. Jack pine and red pine are the dominant tree species. The herbaceous layer is dominated by weedy pioneer species. This is the most common habitat type within the study site. Forestry practices are common throughout habitat type D. Much of the area has been recently clear-cut. In Appendix F-1, WCR identifies four categories of clear-cut areas within habitat type D: 1) no overstory or shrub layer, 2) young red pine with a sparse herbaceous layer, 3) young jack pine with a sparse herbaceous layer, and 4) mix of young deciduous and coniferous forest with a sparse herbaceous layer.

Habitat type G is located on the near vertical face of the peridotite rock outcropping in the northeastern portion of the study site where the mine portal will be constructed (see Figures 2-3 and 3-12). The habitat is dominated by an herbaceous plant community growing in fissures and flats of the bedrock. Spleenwort, rusty woodsia, serviceberry, bush honeysuckle, wild rose, and common blackberry are the common species. Habitat type G blends into the surrounding habitat C1.

Wildlife survey transects were established in the study site. The transects were located to represent all habitat types within the study site. Transects 1, 2, 3, and 4 were located in the eastern portion of the site. The northern end of these transects are located in the vicinity of the main surface facility and are considered to have covered habitat representative of the area for the proposed main surface facility (Appendix E-2). Transects 1, 2, 3, and 4 intersect habitat types D and C1. Stations T3M3B3, T2M2B2, and T1M3B3 are located near the main surface facility in habitat type D. Station T4M3B3 is located in habitat type C1 near the main surface facility. Stations T4M2B2 and T3M2B2 are located south of the main surface facility, but are also located in habitat type C1. Transects 5 and 6 were located in the central portion of the site near the ore body, and backfill surface facility. The northern end of transects 5 and 6 intersect habitat types C2 and D. Stations T5M3B3 and T6M3B3 are located near the ore body and the backfill surface facility in habitat type C2.

The habitats in the study site are used by migrating birds in the spring and fall and by resident species for nesting, resting, and feeding. Bird diversity was relatively high for the size of the study area. Fifty-three species of birds were observed, including a bald eagle. The species are typical bird species for the Upper Peninsula and are commonly found in the habitats observed within the study site. Dark-eyed juncos, yellow-rumped warblers, and white-throated sparrows were a few of the most frequently observed bird species. The diversity of bird species in clear-cut areas was similar to that of forested areas. However, the number of birds observed in clear-cut areas was lower.

The upland wildlife habitats within the Eagle Project study site and in the vicinity of proposed infrastructure are not unique or special habitats with one exception. The peridotite rock outcropping, habitat type G, does support unique niche habitat for plants. However, as documented in Section 3.8 and Appendix F-1 no threatened or endangered plant species were found on the outcrop during surveys. Generally, the predominant habitat type within the 92-acre disturbance limits is upland coniferous pine forests that are in various states of recovery from recent logging and active reforestation (pine plantations).

A variety of bird species use the upland habitats in the vicinity of proposed infrastructure. Migrating and resident birds use the habitat. Bird species observed are typical for the habitat types present and the Upper Peninsula. The composition of bird species observed in forested and clear-cut habitats was similar, but the numbers of birds observed in clear-cut areas was slightly lower. Habitat type C2 supported the highest number of birds of the four habitat types in the vicinity of proposed infrastructure. No threatened or endangered species bird species were observed with the exception of one bald eagle observed in flight from a distance.

A few small mammals were captured and/or observed using the habitat types in the vicinity of proposed infrastructure. No threatened or endangered species of small mammals were captured or observed. In addition, to the eastern chipmunk, red-backed vole, and deer mouse, it is likely that red squirrels also use the habitat.

Scat and tracks of white-tailed deer, moose, black bear, and eastern coyote were observed. No signs of gray wolves were observed, although this species is likely to travel through the area at times. Clear-cut areas lacking deciduous tree regeneration had few signs of large mammal use. Signs of large mammal use were abundant near an area of aspen regeneration located south of Triple A Road and east of the Salmon Trout River.

3.7.2 Potential Impacts to Habitat and Wildlife Species

The primary mechanism for impacts to habitat, flora and fauna are due to mine dewatering and physical disturbance of the landscape. Potential impacts on vegetation (flora) due to mine dewatering are described above in Section 3.6. Hydrologic changes in the wetlands are not expected to measurably affect wildlife (fauna).

Impacts to habitat due to construction of surface facilities will be restricted primarily to habitat that is in various stages of recovery from recent and historic logging activities. No unique or rare habitat or wildlife will be impacted by the construction and operations of the mine.

The main surface facility and backfill facility will be the only sources of impact to upland habitats and associated wildlife. The total fenced facilities and access road surface area is approximately 145 acres. Approximately 88 acres at the main surface facility and 4 acres at the backfill facility will be cleared, grubbed, and stripped of topsoil to allow development of the facilities. The topsoil will be stockpiled for reclamation activities. Total habitat disturbance will therefore be about 92-acres. The surface facilities are related to managing development rock; contact and non-contact water storage, treatment, and discharge; mine ventilation; and other ancillary operations. Ore will be crushed and trucked to rail cars for shipment to an off-site processor. Furthermore, development rock will be temporarily stored within the main facility area at the TDRSA and used for backfilling the mine. The mine backfilling process eliminates permanent above-ground storage of development rock that typically impacts large areas of habitat.

Approximately three-quarters of the 92-acres of upland habitat that will be disturbed is comprised of habitat type D. Habitat type D is a conifer (red pine and jack pine) dominated upland forest habitat that is presently in various stages of growth resulting from cyclical logging and active reforestation. Habitat type D is substantially impacted by forestry. Much of the habitat type D area that will be disturbed by development of the on-site facilities has been recently clear-cut. Habitat type D does contain habitat for resident and migrating birds. When older tree growth is present, habitat D provides habitat for small mammals and deer. However, the current clear-cut areas of habitat type D provide very little wildlife habitat.

Development of the main surface facility will also disturb a smaller area of habitat type C1. Habitat type C1 is an upland forest community dominated by coniferous tree species (white pine, red pine, and jack pine). Habitat type C1 is distinguished from habitat type D by the lack of forestry signs, although habitat C1 is isolated in a clear-cut area. Habitat type C1 contains mixed-age trees without evidence of active reforestation, suggesting the area had naturally regenerated from historical logging. Because the plant community is more diverse and the trees are more mature, habitat type C1 contains more habitat for small mammals and birds. Development of the surface facilities within areas of habitat type C1 will displace some animals. However, habitat type C1 is not unique and the impacted area represents a small fraction of available habitat in the vicinity of the Eagle Project.

Habitat G contains unique niche habitat for plants, although no threatened or endangered species were identified during the surveys. While the mine portal will be located on the west side of the bedrock outcrop that comprises Habitat G, the portal will be developed below the existing

ground surface as indicated in Figure 2-5. Also see Figure 4-7 in Volume I of this *Mining Permit Application*. As such, the Habitat G will remain intact.

Nearly all of the backfill facility is located in habitat type C2. Like habitat type C1, C2 is an isolated upland forest community surrounded by habitat type D to the west, north, and east. Habitat type C2 is bisected by the existing Marquette County road known as Triple A Road. Habitat type C2 is similar to habitat type C1, but contains more deciduous tree species. In addition, habitat type C2 is connected to Habitat types E1 and E2 along the north side of the Salmon Trout River. Due to this connection, the quality of habitat type C2 is higher than that of C1 in the vicinity of the main surface facility. Approximately 4 acres of habitat type C2 north of the Salmon Trout River will be cleared for development of the Backfill Facility. This represents approximately one-third of the total area of habitat type C2 in this area. Approximately two-thirds of the habitat area will not be disturbed. Furthermore, the connection between C2 and E1 and E2 will not be completely eliminated.

The area of impact from development of surface facilities is small relative to the abundance of upland wildlife habitat in the area, upland forests in particular. The selected mining method substantially reduces the area of disturbance by eliminating the need for permanent stockpiling of development rock on the landscape. The quality of impacted upland habitat is also low due to active silviculture. Reforestation practices typically result in monotypical stands of conifers with reduced habitat quality compared to natural upland forests in the vicinity of the Eagle Project. Due to the relatively small disturbance area and low habitat quality, the Eagle Project surface development will not substantially affect upland habitat and associated wildlife. Most importantly, the project will not affect any unique or rare habitats or threatened or endangered plants and animals (Section 3.8). At the end of the project KEMC will reclaim the site and revegetate the land with a mixture of native plant species as described in Volume I of this *Mining Permit Application*. After reclamation is complete the site will contain a more diverse mix of vegetation than currently exists at the project site.

3.8 Threatened and Endangered and Special Concern Species

WCR completed detailed assessment of threatened and endangered and special concern species (T&E Assessment) that covered the biological study area around the Eagle Project site. The T&E assessment report is provided in Appendix F-1. The first step in the T&E assessment was the review of Michigan Natural Features Inventory (MNFI) for listed species of plants and wildlife that could potentially be present within the boundaries of the surface facilities and surrounding environments. The T&E assessment that was completed meets the requirements of R 425.202(2)(y), (aa) and (bb) in that literature sources based on prior studies were used as part of the T&E assessment which also included one year of site specific data collection.

3.8.1 Listed Species within the Study Area

One state-threatened plant species, the narrow leaved gentian (*Gentiana linearis*), occurred on the site as documented by WCR in Appendix F-1. Small clusters of this gentian were mapped by WCR in 12 locations within the floodplain of the Salmon Trout River (see Figure 3-12). Ten of the 12 clusters occurred on the north side of the river. These 10 clusters all occurred on an approximately 1,200-foot reach of the river immediately down stream from the ore body. An eleventh cluster was located on the north side of the river directly over the southern limit of the ore body. The twelfth cluster occurred on the south side of the river approximately 2200 feet

south-southeast of the ore body. Thousands of narrow-leaved gentian plants were documented elsewhere in the region (Appendix F-2).

Another plant resembling the state-endangered small yellow pond lily (*Nuphar pumila*) was collected from the Salmon Trout River south of the ore body. However, positive identification was not possible due to a lack of flowering parts. KEMC plans to conduct studies in 2006 to confirm identity of this plant. It is noted that the location of this plant is located along the southern boundary of the study area (see Appendix F-1) and is outside the area of potential groundwater drawdown.

A bald eagle (*Haliaeetus leucocephalus*; state and federal threatened) was observed flying over the site on one occasion. However, extensive searches of the site failed to uncover any bald eagle nests or suitable bald eagle foraging habitat within the site boundaries.

There were no signs indicating that the gray wolf (*Canis lupus*; state threatened) occurred anywhere on the site. Though not appearing on the MNFI element occurrence list for the area, gray wolves range widely in Michigan's Upper Peninsula, so signs of its presence were sought during the large mammal surveys although none were found.

A number of habitat patches deemed suitable for various listed species occurred on the site. However, no other listed plant or animal was observed in any of these potential habitat patches, or anywhere else on the site, during the field surveys.

3.8.2 Potential Impacts to Narrow-Leaved Gentian

To assess potential impacts to the narrow-leaved gentian, KEMC completed a broad regional study documenting the occurrence of this species in other suitable habitat in northern Marquette County. This regional assessment of the narrow-leaved gentian is provided in Appendix F-2. As documented, the narrow-leaved gentian occurs in habitat areas across northern Marquette County. A significant finding documented in Appendix F-2 is that the narrow-leaved gentian occurs in a variety of hydrologic habitats ranging from wetlands to wetland fringe areas to upland areas. As such the narrow-leaved gentian is tolerant to a variety of hydrologic conditions and local populations near the ore body should tolerate potential changes in hydrology due to mine dewatering.

The minimal water table drawdown is not expected to have any negative impacts on either the bald eagle or the gray wolf, if any were to visit the site. Sufficient water for drinking would remain in the streams and any animal visiting the site could easily avoid the mine entrance and the surface facility. The listed animals are highly mobile and, given the relative lack of suitable habitat for these species on the site, any listed animals moving into the area most likely would move on to other, more suitable habitat in any case.

The plant identified as possibly being the small yellow water lily plant was reported to occur near the southern site boundary. This area is located well upstream from the ore body and is outside any possible cone of depression that might be caused by mine dewatering. There will be no negative impacts on the area where this plant was growing.

Mitigation of potential impacts to listed threatened and endangered species will not be required.

3.9 Invasive Species

This section of the EIA addresses the requirements of R 425.202(2)(cc). Database queries and field surveys of the proposed Eagle Project site were conducted in order to determine whether any state or federal invasive plant or animal species occurred on the site, and to determine whether invasive species pose a threat to habitat occurring on the site.

3.9.1 Invasive Species within Study Area

Invasive species can be classified as native to Michigan or introduced (“exotic”) to Michigan from outside the state. Responsibility for maintaining noxious plant lists falls to the Michigan Department of Agriculture at the state level and the United States Department of Agriculture at the federal level. The Michigan Department of Agriculture breaks the noxious weeds into two subcategories: prohibited noxious weeds and restricted noxious weeds. Prohibited noxious weeds cannot be sold or grown legally in the state. Restricted noxious weeds are those weeds that may occur naturally in the state but are considered either economically detrimental or simply nuisance species.

3.9.1.1 Exotic Noxious Species

The following exotic species as classified by the MNFI appeared in one or more places on the site:

- ♦ *Agropyron repens* - Quack grass
- ♦ *Agrostis gigantean* - Redtop
- ♦ *Dactylis glomerata* - Orchard grass
- ♦ *Hieracium aurantiacum* - Orange hawkweed
- ♦ *Hieracium caespitosum* - King devil
- ♦ *Nasturtium officinale* - Water cress
- ♦ *Pinus sylvestris* - Scots pine
- ♦ *Poa compressa* - Canada blue grass
- ♦ *Poa pratensis* - Kentucky blue grass
- ♦ *Prunella vulgaris* - Self-heal
- ♦ *Ranunculus acris* - Tall buttercup
- ♦ *Rumex acetosa* - Green sorrel
- ♦ *Rumex acetosella* - Sheep sorrel
- ♦ *Taraxacum officinale* - Common dandelion
- ♦ *Typha angustifolia* - Narrow leaf cattail
- ♦ *Verbascum thapsus* - Common mullein
- ♦ *Veronica beccabunga* - Brooklime
- ♦ *Veronica officinalis* - Common speedwell

Of the exotic species listed above, only Quack grass (*Agropyron repens*; a state prohibited noxious weed) appears on either the state or federal noxious weed lists. Quack grass was present in Habitat Area D in the understory of an upland that has been disturbed by logging.

3.9.1.2 Native Noxious Species

Three native noxious species occurred on the site: Canada thistle (*Cirsium arvense*; federal and state prohibited noxious species), bull thistle (*Cirsium vulgare*; federal and state prohibited noxious species) and poison ivy (*Toxicodendron radicans*; federal and state restricted noxious species). Bull thistle and Canada thistle occurred in the understory of a disturbed upland area that at one time was being managed as a pine plantation. Poison ivy occurred on a peridotite rock outcropping.

3.9.2 Potential Impacts from Invasive Species and Mitigation

Potential impacts from the invasive species present at the site will primarily come from periods of time where construction activities are occurring as part of surface facility construction and reclamation.

Invasive species are successful because they become established early and grow quickly, often in relatively harsh environments. In this manner, they out compete other plant species for whatever space, water, nutrients and light are available. Once established, invasive species can suppress native vegetation, quickly reducing the abundance of native plants to nearly zero. The potential exists for this to happen around the surface facility and mine entrance.

Mitigation of Invasive Species Impacts

Vegetation clearing and earthwork will be minimized to that necessary to construct the needed roads, buildings and open storage areas. Cleared areas and areas of disturbed soil will be covered with topsoil and seeded with an appropriate seed mix as soon as possible following disturbance. An invasive species control program will be devised and implemented that will include regular site monitoring and steps to deal with invasive plants when they occur on the site.

3.10 Natural and Wild and Scenic Rivers

This section of the EIA addresses the requirements of R 425.202(2) (n) and (o).

3.10.1 Existing Natural, Wild and Scenic Rivers

There are no rivers in Marquette County that have been designated as “natural rivers” under 30501 NREPA. The closest designated natural rivers are the Fox River and Two Hearted River in the eastern part of the Upper Peninsula. The Federal Congress has the authority to identify wild and scenic rivers under the Wild and Scenic Rivers Act (WSRA) (16 USC 1271, et seq). Once Congress designates a river, the WSRA mandates that the U.S. Forest Service (USFS) manage the designated river “in such a manner as to protect and enhance the values which caused it to be included in said system without, insofar as is consistent therewith, limiting other uses that do not substantially interfere with public use and enjoyment of these values” {16 USC 1281(a)}.

The WSRA also imposes two obligations on the USFS after a river segment is designated. First, USFS must “establish detailed boundaries” for each designated river within one year of the date of designation {16 USC 1274(b)}. Until publication of the detailed boundaries, the WSRA establishes one-quarter mile boundaries measured from the ordinary high water mark on either side of the river. Second, USFS must prepare a “Comprehensive Management Plan” for each

designated river segment that will “provide for the protection of river values” within three fiscal years of the date of designation {16 USC 1274(d)(1)}.

Areas potentially impacted by the proposed mining activity were reviewed to assess the applicability of the WSRA to the overall project. Below is a brief description of possible impacts and how they could affect Wild and Scenic Rivers.

The portion of the Yellow Dog River Watershed from its origin at the outlet of Bulldog Lake Dam to the boundary of the Ottawa National Forest was placed on the Wild and Scenic River list by Congress on March 3, 1992. The listed portion is about four miles west of the Eagle Project site. The Yellow Dog flows in a northeasterly direction, so the listed portion is upstream of the Project site and will not be affected by the Eagle Project.

3.11 Public and Private Buildings

This section addresses the requirements of R 425.202(2)(p). The purpose of this section is to evaluate potential environmental impacts on residential areas, schools, etc. Land in the vicinity of the Eagle Project is primarily used for timber harvesting and recreational purposes. No permanent residences exist in the area. The closest populated area is Big Bay located approximate 10 miles to the northeast. The nearest known residences to the Eagle Project site are:

- ◆ A seasonal camp on Kennecott-owned land approximately 1.4 miles west-northwest of the mine portal.
- ◆ Seasonal camps located at Dodge City approximately 2.2 miles north of the mine portal.
- ◆ A permanent residence approximately 6.4 miles east of the mine portal.

Eagle Project activities will not affect any of the structures identified in R 425.202(2)(p).

3.12 Public Roads, Pipelines and Power Lines

Public Roads, pipelines and power lines provide valuable infrastructure links within Marquette County. This section evaluates potential impacts to these infrastructures per the requirements of R 425.202(2)(q).

3.12.1 Existing Infrastructure

There are no pipelines, or power lines at the project site. Triple A Road runs adjacent to the mining area. This is a seasonal county road with no graded shoulders, and no pavement.

Given the remoteness of the proposed mine development, natural gas will not be piped into the area. Heating requirements will be provided by propane fired heaters to heat air entering the mine during winter. Electric heaters will be used in on-site buildings. As such, the project will not affect natural gas infrastructure in Marquette County. Again, primarily due to the remoteness of the facility, electric power will be generated on site by three diesel powered generators. Therefore, the project will not utilize electricity from on local electric grid. For this reason, no further evaluation of pipelines or power lines was conducted.

Public roads serving the project site include the Marquette County Triple A Road, which is a county road providing direct access to the mine site. Other roads include CR 510 and CR 550. These roads provide transportation linkage south to potential railhead sites, along with commercial and residential services.

3.12.2 Proposed Mining Activities Affecting Infrastructure

KEMC has evaluated needed improvements to Triple A Road and CR 510. KEMC will be working with the Marquette County Road Commission (MCRC) to implement certain necessary upgrades to Triple A Road and CR 510 to allow for increased year round use. During operations and reclamation KEMC will work with the MCRC to provide year round maintenance such as snow removal. Transportation of employees and supplies to and from the site along with the transportation of ore to a railhead in the vicinity of Marquette are the primary activities that could affect infrastructure.

3.12.3 Potential Impacts to Infrastructure and Mitigation

The project will generate roughly 40 truckloads of ore per day, along with transportation demands from suppliers and up to 110 mine employees commuting to the site. KEMC is evaluating minimization of employee traffic through use of a project bus system that would transport employees to the site at designated times during the day. The current transportation linkages require improvements to support this traffic demand. Potential transportation routes are displayed in Figure 2-6. The preferred route is Triple A Road to CR 510 to CR 550 to a railhead in the vicinity of Marquette. The railhead will be an enclosed facility with a concrete floor that will be used for unloading ore from the haul trucks and loading ore onto railcars. The railhead location is currently being negotiated between KEMC and various land owners.

KEMC proposes to make improvements to portions of the trucking route, including the nine miles of Triple A Road to CR 510 and the three miles of CR 510 to CR 550. The road improvements will generally include providing a more stable road base and widening the Triple A Road from the project site to CR 510. Details of these improvements will be worked out between KEMC and the MCRC.

The goal of these improvements will be to provide an all-weather route from the Eagle Project site to the railhead and improve local roads for travel. It is anticipated that these mitigation measures will provide adequate transportation facilities for the project and will improve the transportation linkages from their existing condition.

Currently the Triple A Road is closed during the winter and portions of the road are used by area snowmobile groups. Improving Triple A Road for year round use will eliminate the snowmobile use of the Triple A Road east of the project site. KEMC is working with local recreation organizations to identify and develop alternative snowmobile routes where needed.

3.13 State and Federal Wilderness, Research and Recreational Areas

The location of wilderness, recreational, natural and research areas as defined in R 425.202(r) - (w) were reviewed with respect to their proximity to the project facilities. KEMC reviewed the location of state wilderness, natural, and wild areas designated pursuant to M.C.L. 324.35101 in

the vicinity of the project site. The only wilderness, natural, or wild area in Marquette County is the Rocking Chair Lakes Natural Area. The Rocking Chair Lakes Natural Area is comprised of 240 acres and is located directly east of the Silver Lake Basin approximately a quarter mile to the east of Mulligan Creek. The area is to the south of the site and outside of the area potentially affected by the project.

KEMC also reviewed the location of federal wilderness areas as defined in 16 U.S.C. 1131. The McCormick Wilderness is comprised of 16,850 acres and straddles Baraga and Marquette Counties between the Ottawa National Forest boundary and Hasseib Lake. The McCormick Wilderness includes the portion of the Yellow Dog River watershed from the Bulldog Lake Dam to the boundary of the Ottawa National Forest. The McCormick Wilderness is about four miles west of the project site, but is upstream of the project site and will otherwise not be affected by the project.

Further, KEMC reviewed the location of federal research natural areas as defined in 36 C.F.R. 251.23. The only research natural area that currently exists in Marquette County is the McCormick Research Natural Area located in the northeast corner of the McCormick Wilderness. As with the McCormick Wilderness, the project will not affect the McCormick Research Natural Area.

There are several state designated recreational areas near the proposed mining site. The Van Riper State Park and Craig Lake State Park are located about 5 to 10 miles to the south of the site but are outside of the area potentially affected by the project as defined by surface facility construction limits and area of groundwater drawdown. There are also several state forest campgrounds located about 10 to 20 miles to the south of the mine site. Once again, given the distance, it is not expected that mining activities should have an impact on recreation in these areas.

3.14 Land Use

This section of the EIA addresses the requirements of R 425.202(2)(x).

3.14.1 Existing and Historical Land Use Conditions

Pre-settlement vegetation of the Yellow Dog Plains was predominantly hemlock, northern hardwoods and white pine. Other species such as red pine and red oak dominated exposed bedrock ridges. Jack pine forests dominated the outwash sands of the Yellow Dog Plains. Balsam fir, tamarack and black spruce were the most common original species in the wetland areas.

Logging and mining have been a major part of land use activities for over 150 years. Copper mining on the Keweenaw Peninsula has been conducted since before recorded history. Mining for iron in the Marquette Range historically created many large open-pit mines in the area. Logging is ongoing throughout the region including recent extensive clear-cutting of second growth jack pine forests on the Yellow Dog plain.

The project is situated on the Yellow Dog Plain near the headwaters of the Salmon Trout. At the present time the land is used for timber harvesting and for recreational purposes. No permanent

residences exist in the area. The closest populated area is Big Bay located approximately 10 miles to the northeast.

The Eagle Project is located entirely in Sections 11 and 12, T50N-R29W, Marquette County, Michigan. Sections 11 and 12 are located entirely within Michigamme Township. Figure 2-1 is a reproduction of the Michigamme Township Official Zoning Map “D/E” dated May 25, 1992 showing that the Eagle Project is located in Michigamme Township Zoning District RP-20. On land zoned as RP-20 (Resources Production Twenty), mineral extraction is a locally permitted principal use.

3.14.2 Proposed Mining Activities Affecting Land Use

Mining activities will require that a portion of the site be removed from commercial forestry production to facilitate construction of access roads, and other mine related facilities. This area is anticipated to be roughly 145 acres. Development of the site will include surface grading, road construction, drainage controls and construction of structures associated with the surface facilities.

Approximately 1,600 acres of Kennecott owned land in the area is entered into the Commercial Forestry Act (CFA) program. This program is managed by the Michigan Department of Natural Resources to encourage good forestry practices.

As a result of the project, the aforementioned mine surface facilities will be fenced and the public will be excluded from entry for safety reasons. This area will need to be removed from the CFA designation. Once the project is complete and the site restored, commercial forestry production will continue to be a likely land use.

Other potential impacts to land could occur during development and construction of the site. These could include air emissions and erosion of developed land during storm events. These potential impacts have been addressed elsewhere in this document

3.14.3 Mitigation of Impacts to Land Use

Although a small portion of the area will be removed from the CFA program during the life of the mine, it is not anticipated this should have a significant impact on good forestry practices. During the life of the mine, the property will be properly maintained to ensure the mining operations are carried out in a safe and environmentally acceptable manner. During development and construction of the site, potential impacts to the land such as air emissions and soil erosion will be properly controlled through environmental controls specified in applicable permit applications. These will include use of water trucks to control dust during development and use of vegetation and soil control mats to reduce the possibility of soil erosion. Frequent inspections of the land will occur to ensure these controls continue to be effective so that the site can be reclaimed to a natural sustainable state.

3.15 Aquatic Resources

Baseline studies have been completed to assess potential impacts to aquatic resources. The study area for aquatic resources included the Salmon Trout River, that portion of the Yellow Dog River south of the Eagle Project site and Cedar Creek.

Aquatic resources in the mining area include the stretch of the Salmon Trout River that is south of the Triple A Road and flows over the footprint of the ore body and underground mine. The hydrology of the potentially affected watersheds discussed in this aquatic impact analysis is described in Section 3.4 and reports provided in Appendix B.

The Salmon Trout River, Yellow Dog River and Cedar Creek flow through relatively undeveloped forested watersheds and are considered coldwater trout streams by the Michigan Department of Natural Resources (MDNR). Coldwater streams provide sufficient habitat to produce sustainable populations of salmonid species such as brook trout (*Salvelinus fontinalis*). Coldwater systems are important from an ecosystem perspective because they typically contribute to, and moderate, water quality in downstream areas. Coldwater streams also contribute to overall species diversity and richness within local (e.g., watershed) and regional (e.g., Upper Peninsula) ecosystems. Salmonid species that typically inhabit coldwater systems are also important as a recreational fishing interest in Michigan.

The analyses of these coldwater streams (the Salmon Trout River, Yellow Dog River, and Cedar Creek) included an examination of chemical, physical, and biological parameters to evaluate impacts related to the proposed mining activities. These investigations included a combination of qualitative and quantitative evaluations. The baseline data that has been collected will be incorporated into the monitoring plan for the Eagle Project to assess potential changes in aquatic systems during the mine operations and post-closure periods.

The studies that have been conducted to characterize the existing aquatic ecosystems in and near the project area to establish baseline environmental conditions include:

- ♦ White Water Associates, Inc. 2005. *Baseline Limnological Studies of Streams in the Vicinity of a Proposed Sulfide Mine in Marquette County, Michigan*, (prepared for the MDEQ, and hereafter referred to as the MDEQ study). This report investigated water and sediment chemistry, fish community, aquatic macroinvertebrate community, periphyton, habitat, and to a lesser extent, aquatic macrophytes. Field work was conducted on the Salmon Trout River, Yellow Dog River, Big Pup Creek (tributary of the Yellow Dog River), and in Cedar Creek.
- ♦ Wetland & Coastal Resource, Inc. (WCR) 2005. *Aquatic Assessment*., WCR investigated fish, aquatic macroinvertebrates, and habitat in the Salmon Trout River, the Yellow Dog River, and in Cedar Creek.
- ♦ King & MacGregor Environmental (KME) investigated fish, aquatic macroinvertebrates, and stream habitat in the stretch of the Salmon Trout River south of the Triple A Road on November 3 and 4, 2006.

Figure 3-7 displays the location of aquatic sampling locations for the MDEQ, WCR and KME studies. The studies were conducted over a two year period and exceeds the requirements of R 425.202(2)(y) and (z). Copies of the aquatic study reports prepared by WCR and MDEQ are provided in Appendix G. KME's study findings are reported directly in this section of the EIA.

The aquatic assessments referenced in this EIA employed several methods. In Michigan, the Great Lakes and Environmental Assessment Section (GLEAS) Procedure #51, Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers (Creal et al. 1998; MDEQ, 2002) is commonly used for conducting evaluations of stream quality. Procedure 51 methodology includes an investigation of fish, macroinvertebrates, and stream habitat, and was used in all three of the studies that are included in this assessment. Additional quantitative analysis, such as a multi-pass removal technique (Van Deventer and Platts 1983), was used by the MDEQ and KME to provide a detailed evaluation of fish distribution and abundance.

3.15.1 Aquatic Biota within Study Area

3.15.1.1 Fish

The data collected from these studies provides a general description of the fish communities, and in some locations, estimates of brook trout density. The investigations of fish communities also provide baseline data of fish occurrence and distribution throughout the Salmon Trout River and the Yellow Dog River.

Salmon Trout River

Evidence from the three aforementioned studies conducted in the Salmon Trout River indicates that the stream fishery is consistent with the MDNR designation as a coldwater trout stream. Brook trout and other coldwater species, such as northern redbelly dace (*Phoxinus eos*) that are typically associated with such systems, were frequently collected in all three studies reviewed for this assessment (Table 3-5).

Table 3-5
List of Fish Collected Within the Salmon Trout River
in 2004 and 2005

Common Name	Scientific Name
Brook stickleback	<i>Culaea inconstans</i>
Pearl dace	<i>Margariscus nachtriebi</i>
Northern redbelly dace	<i>Phoxinus eos</i>
Finescale dace	<i>Phoxinus neogaeus</i>
Brook trout	<i>Salvelinus fontinalis</i>

Note: Based on studies completed by: WCR, MDEQ, and KME

The Salmon Trout River is also known to support a self-sustaining population of migratory brook trout known as “coasters” in the lower reaches of the river. However, waterfalls and other impassable dams (see Figure 3-1) function as migration barriers to the upstream reaches, including the headwaters of the Salmon Trout River Main Branch south of Triple A Road in the vicinity of the proposed underground mine.

Becker (1983) defines a coaster brook trout as “any brook trout that spends part of its life in Lake Superior.” In the 1800’s, local residents called brook trout “coasters” because of their preference for rocky, near-shore habitat (Newman et al. 2003). Coasters are much larger at maturity than other brook trout, with a maximum size of approximately 11 pounds. They appear to be

relatively short lived, with few individuals surviving beyond five years (Naiman et al. 1987; Bullen 1988).

Coasters typically choose spawning sites within downstream reaches near river mouth areas (Slade 1994), and near-shore lacustrine and estuarine settings (Scott and Crossman 1973). Specific conditions required for redd (spawning bed) locations include loose silt-free gravel or coarse sand over strong groundwater seepage. Thermal stability appears to be a key factor in the use of spring seeps as redd sites (Newman 1996).

The genetic distinctness of coasters remains unclear. The Great Lakes Fisheries Commission (Newman, 1996) recommended genetic and behavioral studies be conducted to describe existing coaster stocks so that comparisons can be made with resident stream brook trout populations.

Northern Michigan University professor Jill Leonard has conducted research on the coasters to determine if they are a separate species of brook trout or a brook trout that grows to a large size because it lives in Lake Superior. She has indicated the coaster is not a separate species (Michigan Technological University News, May 2005), but she and others continue to look for genetic or physiological characteristics that set them apart. A Michigan Department of Natural Resources study (Scribner 2004) indicates that the researchers found evidence that the coaster and resident brook trout from the Salmon Trout River are “reproductively isolated.” Ongoing research is trying to answer the questions about the genetics and behavior of coasters in order to understand how best to manage their populations.

The Salmon Trout River Main Branch south of Triple A Road was predominantly comprised of brook stickleback (*Culaea inconstans*) and northern redbelly dace. Brook trout were also captured within these reaches, but were not the most abundant species. The KME fish sampling was conducted upstream of the Triple A Road, well above the WCR sampling stations, and in close proximity to the existing ore body (Figure 3-7). The KME sampling event was conducted on November 3, 2005, at a time when brook trout are typically observed spawning in Michigan streams. A total of 16 brook trout ranging in size from two inches to eight inches were collected.

Fish density estimates within the Salmon Trout River Main Branch in the immediate vicinity of the ore body were determined from the November 3, 2005 KME sampling event. A total of 16 brook trout (removal pattern: 1st pass = 11, 2nd pass = 4, 3rd pass = 1) were collected in Site 6 (Figure 3-7). The density of brook trout within Site 6 was estimated to be 175 fish/km and 256 fish/ha.

Although sampling was conducted upstream of the ore body by both the MDEQ and KME (Site 7, Figure 3-7), estimates of brook trout density are not possible from the information used in this assessment. Because of substantial habitat complexity (e.g., numerous pathways to areas of flooded vegetation) caused by beaver dams, it was difficult to achieve adequate blocking of the stream channel using block nets for a multi-pass removal procedure.

Fisheries data of the Salmon Trout River downstream of the ore body were collected by WCR and the MDEQ from sample locations shown on Figure 3-7. The study conducted by WCR included two study reaches that were located immediately upstream and downstream of Triple A Road and another study reach that was located further downstream of Triple A Road (Figure 3-7). The brook trout was the only species detected at Station 1 and Station 3 in the WCR study.

Brook trout, brook stickleback, finescale dace (*Phoxinus neogaeus*), northern redbelly dace, and pearl dace (*Margariscus nachtriebi*) were collected by WCR from Station 2.

The MDEQ study detected brook trout, brook stickleback, and northern redbelly dace within their downstream-most study reach (Station 3) more than 2-miles downstream of Triple A Road (Figure 3-7). Eleven brook trout were documented by MDEQ at Station 4, which was located immediately downstream of Triple A Road and coincided with WCR's Station 3 (Figure 3-7). The density of brook trout within MDEQs Station 4 was estimated to be 286 brook trout/km and 1,084 brook trout/ha.

Yellow Dog River

MDEQ and WCR fish sampling data from the Yellow Dog River and its tributary, Big Pup Creek, are consistent with its coldwater trout stream designation (Table 3-6). Brook trout as well as other species, such as blacknose dace (*Rhinichthys obtusus*), and rainbow trout (*Oncorhynchus mykiss*), which are typically associated with coldwater streams are present within the system. However it is noted that the Yellow Dog fishery has been supplemented by the MDNR fisheries division with periodic plantings of trout species.

Table 3-6
Fish Collected from the Yellow Dog River
and Big Pup Creek in 2004

Common Name	Scientific Name
Brook stickleback	<i>Culaea inconstans</i>
Brook trout	<i>Salvelinus fontinalis</i>
Brown trout	<i>Salmo trutta</i>
Blacknose dace	<i>Rhinichthys obtusus</i>
Creek chub	<i>Semotilus atromaculatus</i>
Longnose dace	<i>Rhinichthys cataractae</i>
Mottled sculpin	<i>Cottus bairdii</i>
Rainbow trout	<i>Oncorhynchus mykiss</i>
White sucker	<i>Catostomus commersoni</i>

Note: Data based on studies from MDEQ and WCR.

The Yellow Dog River was sampled in the same location by the MDEQ (Station 2) and WCR (Station 5) in 2004. This location was approximately one mile south of Triple A Road and approximately two miles southeast of the headwater origin of the Salmon Trout River Main Branch (Figure 3-7). A total of two brook trout were captured by the MDEQ at this location. Additional species that were captured included the creek chub (*Semotilus atromaculatus*), brook stickleback, blacknose dace, and mottled sculpin (*Cottus bairdii*). WCR captured 10 longnose dace (*Rhinichthys cataractae*) and two mottled sculpin.

The MDEQ also sampled another location approximately downstream of their Station 2 at the CR 510 crossing of the Yellow Dog River. Although no brook trout were collected, other trout species such as brown trout (*Salmo trutta*) and rainbow trout were collected. Only brook trout were collected from the MDEQ Station 6, which was located on Big Pup Creek, a tributary of the Yellow Dog River (see exhibit 1 in Appendix G-2).

Cedar Creek

The same location was sampled on Cedar Creek by both the MDEQ (Station 5) and by WCR (Station 4) in 2004 (Figure 3-7). No other locations within Cedar Creek were sampled. Brook trout and northern redbelly dace were the only species observed at this sample location.

3.15.2 Macroinvertebrates

Macroinvertebrate diversity is generally indicative of favorable aquatic conditions. Macroinvertebrate taxa, such as mayflies, caddisflies, and stoneflies are good biological indicators of aquatic system health. This is especially true of coldwater stream systems where macroinvertebrates are sensitive to aquatic habitat and water quality degradation, and provide a good indicator of stream health over time.

Macroinvertebrates were sampled in all reaches investigated by the MDEQ, except Station 7 on the Salmon Trout River, and in all reaches sampled by WCR, and KME (Figures 3-7). Macroinvertebrate sampling in investigations evaluated for this assessment, used methodology that was consistent with Procedure 51 (Creal et al. 1998; MDEQ 2002).

Salmon Trout River

Evidence from the MDEQ and WCR studies in the Salmon Trout River indicates a healthy coldwater community of macroinvertebrates, both in species richness and overall abundance. Commonly identified taxa included mayflies (*Ephemeroptera*), caddisflies (*Trichoptera*), and various fly larvae (*Diptera*).

KME collected macroinvertebrates at Site 6 and Site 7 on November 3, 2005 following sampling of the fish community. The stream hydrology of both sites was affected by beaver activity throughout the stretch of the Salmon Trout River Main Branch near the ore body. Although it is recommended to avoid conducting Procedure 51 macroinvertebrate sampling in the vicinity of impounded waters (Creal et al. 1998; MDEQ 2002), it was completed by KME to gain a better understanding of the macroinvertebrate community in the Salmon Trout River Main Branch in the immediate vicinity of the ore body.

The macroinvertebrate communities within Site 6 and Site 7 were typical of an impounded water body. Surface-dependent organisms, such as water boatmen (*Corixidae*), were abundant at both locations. Amphipods (scuds), which are often found in locations with an abundance of organic matter, were also abundant within these two sites. Caddisflies, and dragonflies (*Odonata*) were frequently collected, but were not as abundant as the water boatmen and amphipods. Because of the beaver activity within Site 6 and Site 7, Procedure 51 macroinvertebrate community rating scores were not developed for these locations.

MDEQ Station 4 is located immediately downstream of Triple A Road (Figure 3-7), and was rated as an acceptable macroinvertebrate community. MDEQ Station 3 was rated as an excellent macroinvertebrate community.

WCR Station 1 and Station 3, which were located downstream of Triple A Road (Figure 3-7), were rated as excellent macroinvertebrate communities. Although Station 3 was considered excellent by WCR, it is the same location sampled by the MDEQ (Station 4), which considered it

an acceptable macroinvertebrate community. *Dipterans* and caddisflies were the most abundant taxa within WCR's Station 1 and Station 3. WCR Station 2 located immediately upstream of Triple A Road, was rated as an acceptable macroinvertebrate community by WCR. Because of its close proximity to the stream habitat that was influenced by beaver activity, the macroinvertebrate community within Station 2 is similar to the macroinvertebrate community that was sampled by KME in Site 6. Approximately 10 percent of the Station 2 sample consisted of taxa that are surface-dependent air breathers. Although the damselfly (*Calopterygidae*) was the most abundant taxa within Station 2, mayflies and caddisflies were also present within the sample.

Yellow Dog River

Evidence from the MDEQ and WCR studies in the Yellow Dog River also indicated a diverse macroinvertebrate community. Mayflies, caddisflies, and dipteran larvae comprised the majority of the macroinvertebrate community. The MDEQ's Station 1 and 2 (see Figure 3-7), and Station 6 on Big Pup Creek (see exhibit 1 in Appendix G-2) were all rated as excellent macroinvertebrate communities.

WCR Station 5 was the same location as the MDEQ Station 2 (Figure 3-7). Although the MDEQ identified the site as an excellent macroinvertebrate community, WCR identified the site as an acceptable macroinvertebrate community based on the taxa collected at this location. WCR collected taxa that are surface dependent, which likely contributed to the lower community rating. The difference in macroinvertebrate community ratings may be related to seasonal changes in abundance of macroinvertebrate taxa, which could influence the Procedure 51 macroinvertebrate community rating. The MDEQ and WCR collected macroinvertebrate samples on different dates during 2004.

Cedar Creek

Cedar Creek was sampled in the same location by the MDEQ (Station 5) and WCR (Station 4, Figure 3-7). Similar to the Salmon Trout River and Yellow Dog River, Cedar Creek contained a diversity of macroinvertebrate taxa including a predominance of mayflies, stoneflies, and dipterans. The MDEQ rated the macroinvertebrate community in this location as excellent and WCR rated the macroinvertebrate community as acceptable. The differences in macroinvertebrate community ratings may be attributed to differences in sample collection dates between the MDEQ and WCR sampling events.

3.15.3 Aquatic Habitat

Aquatic habitat quality is a function of surficial geology of the surrounding watershed, land use patterns, climatic conditions, and other factors, such as natural and manmade habitat alterations within these aquatic systems. Generally speaking, the aquatic habitats of the streams that were investigated as part of this assessment were of sufficient quality to support healthy coldwater fisheries and an abundance and diversity of macroinvertebrates.

Water quality as measured by the MDEQ (Appendix G-2) was generally good at all sample locations. Nutrients such as total phosphorus were observed at low levels that are characteristic of this region. None of the elements measured by the MDEQ were observed at levels that exceed the Michigan Water Quality Standards, with the exception of total mercury, which periodically exceeded MDEQ water quality standard of 1.3 ppt. However, these mercury results appeared

consistent with reported mercury concentrations in other Michigan streams (Aiello 2004) and current mercury concentrations found in precipitation from the upper Midwest.

Salmon Trout River

The physical character of aquatic habitat of the Salmon Trout River varies along the length of this system. As previously described, much of the Salmon Trout River watershed is forested and undeveloped. The forested habitat along the river includes upland scrub pines associated with the Yellow Dog Plains area, northern hardwood forest north of the project site and forested wetland habitat that is associated with the headwaters and along the margins of the stream corridor (Figure 3-8). Numerous beaver dams, manmade impoundments, and waterfalls are notable habitat features that can be found throughout this watershed (Figure 3-7 and 3-8).

The Salmon Trout River originates in an extensive forested and scrub-shrub wetland system dominated by mixed stands of emergent marsh, tag alder (*Alnus rugosa*), northern white cedar (*Thuja occidentalis*), Eastern hemlock (*Tsuga Canadensis*), balsam fir (*Abies balsamea*), and black spruce (*Picea mariana*). This headwater region, including the river channel downstream to Triple A Road, is a low-gradient system with an abundance of organic matter in the river's substrate. Beaver dams are frequent throughout the Salmon Trout River Main Branch south of Triple A Road.

In the upland of the Yellow Dog Plains, Jack pine (*Pinus banksiana*) and quaking aspen (*Populus tremuloides*) are the predominant tree species found growing in the sandy medium that typifies the surficial geology of this area. Logging activity is readily observed throughout much of the upland area and there is little development within the headwaters and throughout the watershed, with the exception of logging trails, Triple A Road (graveled), and the occasional hunting cabin on private property.

Abundant woody riparian vegetation contributes woody debris to the stream channel providing habitat complexity to this aquatic system. In addition, emergent vegetation contributes to streambank stability and also provides valuable habitat to the aquatic species that make use of this system.

Water chemistry within the Salmon Trout River Main Branch is typical of a system originating in a region dominated by nutrient-poor sand and is heavily influenced by beaver activity (see data in Appendix B). Dissolved oxygen levels are variable and related to the occurrence of impounded water from beaver activities. Similarly, beaver activity likely influences water temperature by impounding water and allowing warming of the slow-moving stream water.

Immediately downstream of Triple A Road, the river channel is generally narrower (approximately six-feet to nine-feet wide) and experiences a steeper gradient than was observed within the headwaters of the Salmon Trout River Main Branch south of Triple A Road. Eel grass (*Vallisneria americana*), watercress (*Nausturtium officianale*), and attached algae were observed within this section of the Salmon Trout River. The streambank was vegetated with tag alder, balsam fir, and a variety of herbaceous cover, including bluejoint grass (*Calamagrostis canadensis*), and swamp thistle (*Cirsium muticum*). In some locations, the vegetation overstory completely covered the stream channel.

Habitat within this reach was rated as excellent according to the Procedure 51 evaluation that was conducted by the MDEQ and WCR. Specific conductivity and dissolved oxygen was generally higher and more stable than was observed within the region of the Salmon Trout River Main Branch south of Triple A Road.

Lower Salmon Trout River

The lower stretches of the Salmon Trout River contain notable features that include the Lower Falls, Middle Falls, and Upper Falls. These waterfalls act as upstream migration barriers to fish such as the coaster brook trout. Other fish migration barriers include two impoundments (Burnt Dam and Lower Dam) located along the river. These impoundments also have the potential to degrade water quality by warming water temperatures by impeding water flow.

Yellow Dog River

The Yellow Dog River originates in a series of headwater lakes, streams and forested wetlands several miles west of the project area in Baraga County. This watershed is virtually undeveloped, and is similar in composition to the Salmon Trout River watershed. The main branch of the Yellow Dog River flows to the east, passing through the project area. In the proximity of the proposed project area, the Yellow Dog River continues to be fed from riparian wetland systems. The stream banks are well vegetated. Beaver are also active within this watershed.

Sample locations on the Yellow Dog River that are located south of the Eagle Project site contain habitat that was rated good by both MDEQ and WCR (MDEQ station 2, and WCR station 5). Tag alder was abundant along the streambank throughout this location. Dissolved oxygen as recorded by the MDEQ ranged from 7.6 mg/L on September 14, 2004 to 13.9 mg/L on November 9, 2004. The average water temperature as recorded by the MDEQ was 15.1 °C from May, 2004 through October, 2004, and varied ± 6.3 °C.

Station 1 and Station 6 (located on Big Pup Creek) were classified as good habitat by the MDEQ. Although these stations were rated as good, they were recorded at the high end of the “good” Procedure 51 habitat scale.

Cedar Creek

Cedar Creek was rated as excellent habitat by the MDEQ and WCR using Procedure 51 methodology. However, WCR identified a riffle/run segment that when scored individually, was rated as good habitat. WCR observed the effects of sediment deposition, which contributed to the lower habitat score within the riffle/run segment.

Riparian cover was observed to occur as dense stands of tag alder. Eel grass, star duckweed (*Lemna trisulca*), slender naiad (*Najas flexicalis*), and filamentous algae were also observed in the sample station. Dissolved oxygen ranged from 8.0 mg/L on November 9, 2004 to 13.1 mg/L on October 5, 2004. The average water temperature as recorded by the MDEQ was 12.6 °C from May, 2004 through October, 2004, and varied ± 4.4 °C.

3.15.4 Potential Impacts to Aquatic Systems and Mitigation

Potential impacts to aquatic biota due to changes in water chemistry, changes in flow through affected streams, and direct impacts to aquatic habitat is constrained to the Salmon Trout River as discussed in Sections 3.2 and 3.4. As discussed in Sections 3.2 and 3.4, it is highly unlikely

that there will be any water quality changes to potentially affected streams, such as the Salmon Trout River. There will also be no direct impact or disturbance to aquatic habitat. As such the potential cumulative impact to aquatic habitat and species will be limited to that which can occur due to mine dewatering induced reductions in stream flow and water levels. Note that as described in Section 3.4, these changes in flow and water levels represent numeric groundwater model precision that cannot be measured in natural systems.

Fish

Impacts to fish populations are expected to be minimal. Impacts to stream flows and water levels at key monitoring stations are summarized in Tables 3-1 and 3-2 for expected case and upper bound estimates of groundwater flow into the mine. The predicted changes are de minimus. The magnitude of stream flow and in-stream water level changes in the reduction in the Salmon Trout River are de minimus and therefore will have a no measurable impact on fish species within the vicinity of the ore body, or elsewhere throughout either watershed.

The theoretical changes in flow are within natural variation and therefore will have no affect on in-stream temperature during the summer.

The proposed project area is located far upstream from any historical or contemporary use of the Salmon Trout River by coaster brook trout. Anticipated impacts of the project on water quality are not expected (see Section 3.4) and any minor changes in flow around the project site will be negated within a short distance downstream from the project area. It is anticipated there will be no detectable influence on water quality or quantity from the proposed mining activities in the downstream areas of the Salmon Trout River that are used by coaster usage of the Salmon Trout River.

Macroinvertebrates

The impacts to the macroinvertebrates of the Salmon Trout River as a result of mining operations are expected to be similar to the impacts to the fish communities. These impacts to the macroinvertebrates are also expected to be de minimus.

Habitat

In-stream and riparian habitat features, such as woody debris and graveled stream bottoms would be minimally impacted by the project as no direct dredging, filling, or construction activities are proposed within either the Salmon Trout River, or adjacent wetlands. Even on upland sites in the project area there will be little infrastructure needed for the mining operations. To minimize impacts to the aquatic habitat and to ensure there will be no physical disturbances to the aquatic biota, the mining operations include designed isolation distances between the areas of mining related disturbance and the aquatic ecosystems.

The reduction in streamflow from dewatering operations is expected to have a de minimus impact on aquatic habitat. The fluvial geomorphology of the Salmon Trout River is not expected to experience a measurable change as a result of the proposed mining activities.

3.16 Cultural, Historical and Archeological Resources

This section of the EIA is provided to meet the requirements of R 425.202(2)(ee). Archaeologists from BHE Environmental, Inc. (BHE) of Cincinnati, Ohio performed a Phase I

Archaeological Survey for the proposed Eagle Project. The Phase I survey involved the examination of approximately 73 acres of land in rural Marquette County, in a forested and clear-cut portion of the Yellow Dog River and Salmon Trout River watersheds. In addition to the formal, set-interval Phase I survey conducted by BHE on the 73 acres, easily accessible portions of a 199-acre study area were subject to a cursory visual inspection for surficial evidence of cultural properties. The results of the BHE Phase I Archaeological survey are provided in Appendix H.

BHE's Phase I survey involved the implementation of a variety of archaeological and archival methods, including literature review pertaining to the region, an inventory of all previously identified cultural resources within one mile of the project area, and a field reconnaissance of the project area. Methods used by BHE were designed to comply with federal regulations including the National Historic Preservation Act (Public Law 89-665, as amended by Public Law 96-515) and the guidelines set forth by the Michigan Historic Preservation Office (MHPO). Field assessments occurred in June 2004 and July 2005.

3.16.1 Archaeological Findings and Evaluation of Potential Impacts

The Phase I survey involved examination of most of the area that will be disturbed due to construction of the mine facilities. BHE's intensive 15-meter interval Phase I archaeological survey determined that no cultural properties potentially eligible or eligible to the National Register of Historic Places (NRHP) exist within the proposed construction footprint of the project.

The BHE Environmental cursory visual inspection of the larger 199 acres surrounding the areas anticipated to be disturbed did delineate three previously unrecorded areas of cultural activity; one prehistoric site and a pair of logging camps of indeterminate age and association. The prehistoric site consisted of a small scatter of prehistoric debris identified from the surface of road cut that is not within the boundaries of the mine site. Since the debris was discovered in a disturbed area of a utilized roadway the prehistoric context of the scatter could not be assessed. The logging camps are historic-era occupations outside the area of proposed disturbance and are most likely early to mid 20th century logging camps. Both of these camps are situated adjacent to existing roads and both contain evidence of structural foundations. The current scope of the project does not involve any ground disturbance within (or adjacent to) any of the areas identified. There were no Paleo-Indian or historic artifacts found at the rock outcrop that will be used for construction of the mine portal (see Figures 2-3 and 3-13).

The construction of the mining facilities will disturb the ground surface in an area of approximately 92-acres.

Since no cultural resources were identified in the area of proposed construction activities potential impacts to cultural and historic resources are not anticipated.

3.17 Air Quality and Climatology

This section of the EIA presents information required under R 425.202(2)(ff) and (gg).

3.17.1 Existing Air and Climate Conditions within the Study Area

The proposed Eagle Project is located in Marquette County, in an area northwest of the city of Marquette. The mine site will be located on an open plain, but is surrounded by rolling hills and wooded areas. Based on information from the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), Lake Superior causes a lake effect on the area's climate and is quite strong during much of the year, increasing cloudiness and snowfall during the fall and winter. This aspect, combined with the higher elevation, yields much higher snowfall amounts than at the city of Marquette. Based on information from the Marquette Weather Observation Station, the average seasonal snowfall for the area is 132.6 inches, although this amount may be greater for inland areas near Lake Superior, such as the Eagle Project site (USDA Climatic Data Narrative for Michigan).

Based on information from the on-site meteorological station, the dominant wind was primarily from the southwest with an average horizontal wind speed of 6.9 miles per hour (mph) during this same period. Average temperature ranged from 13.6° F in January 2005 to 62.1° F in September 2004. Average monthly relative humidity ranged from 60 percent in April to 87 percent in December. Average monthly solar radiation ranged from 26 watts per square meter (W/m²) for December 2004 to 273 W/m² for June 2004. Total monthly precipitation ranged from 0.2 inches in January 2005 to 5.4 inches in August 2004. The meteorological study for the Eagle Project is provided in Appendix I-1.

Meteorological data from the mine site are available for approximately 11 months. In addition to data from the on-site meteorological station, data regarding wind speed, wind direction, temperature and humidity are readily available from the Sawyer International Airport near Gwinn, Michigan. With the exception of snowfall, these data are believed to reflect similar conditions to those found at the site and provide additional information to predict the seasonal and long-term variations at the site. Wind roses for the years 2003 and 2004 at this station in fact correlate very closely with wind data for the site in that they also indicate dominant winds from the southwest. The wind roses are included in Appendix I-2.

At the Eagle Project site, PM₁₀ monitoring data have been collected on an hourly basis. The data report in Appendix I-1 contains data for the period of June 2004 to May 2005. None of the PM₁₀ data have exceeded the EPA 24-hour ambient standard of 150 µg/m³. A review of the PM₁₀ data indicates that particulate concentrations vary seasonally. This seasonal variation may be due to factors such as precipitation, local recreational and silvicultural activities and biological activity (e.g., pollen). Daily PM₁₀ values are generally lower during the winter months when snowfall reduces the potential for mobilization of wind blown dust. The maximum 24-hour PM₁₀ concentration was 57 µg/m³ on September 5, 2004, with the second highest daily concentration being 50 µg/m³, recorded on September 4, 2004.

In addition to collecting baseline data for PM₁₀ at the site, several of the filter tapes used in the dust monitoring process were analyzed for background metals concentrations. Background samples were also collected for nitrogen oxides and sulfur dioxide. The results of these data are summarized in Appendix I-3.

3.17.2 Proposed Mining Activities Affecting Air Quality

Proposed mining activities at the site will potentially affect air quality in the general vicinity of the facility during three phases of activity. These activities will include construction, operations and reclamation.

During the construction phase, it is anticipated that certain surface construction activities could affect ambient air quality. These activities could include disturbance of surface soils, development of soil stockpiles and vehicle traffic. Once mine facilities are completed, facility operations could also have processes that could affect ambient air quality. These could include fugitive dust from ore processing, exhaust from operation of diesel generators, fugitive dust from material stockpiles, exhaust of emissions from underground operations through the ventilation raise and fugitive dust from vehicle travel on and off-site. Once operations are completed, the site will undergo reclamation. During this final stage, operations that could affect air quality could include movement of vehicles, disturbance of soils and development of material stockpiles.

3.17.3 Potential Impacts to Air Quality and Methods of Mitigation

During the construction phase, it is anticipated that fugitive dust from disturbance of soils, development of soil stockpiles and vehicle traffic could impact ambient air quality. Impacts could be in the form of elevated ambient concentrations of particulate matter and deposition in the surrounding area. The likely cause of the fugitive dust would be wind blowing over the surface of newly exposed areas of soil created during construction. To mitigate this potential impact, newly exposed areas will be temporarily re-vegetated and/or covered to minimize the potential for wind blown dust and/or erosion. After final grading of embankment slopes, permanent vegetation will be planted for soil stabilization and to reduce wind blown dust. Vegetated areas will also incorporate a protective mat to keep vegetation in place and to ensure dust is not mobilized. Once areas are re-vegetated and storage piles covered, these areas will be closely monitored. To the extent necessary, roadways established during the construction phase will be kept wet during dry periods of the year. This will be accomplished through use of a watering program over identified traffic areas.

During operation of the mine, estimated potential emissions from the facility are described and quantified in the project's *Michigan Air Use Permit – Permit to Install Application* (Foth & Van Dyke, 2005). Potential sources of emissions that could impact ambient air quality and the environment will include fugitive dust associated with material storage and ore processing areas, exhaust emissions from operation of diesel generators and exhaust of emissions from underground operations through the ventilation raise. Other emissions having a potential impact on the surrounding area may include exhaust and fugitive dust from vehicle traffic. Impacts would be elevated ambient air concentrations of criteria pollutants such as particulate matter, nitrogen dioxide, sulfur dioxide and carbon monoxide; and airborne metals, such as copper and nickel. If emissions are not controlled to comply with air quality standards, deposition of particulate matter and metals could also be a resultant impact.

To mitigate impacts from these potential emission sources, certain engineering controls will be employed during various steps in the mining process. These controls will include use of building enclosures or geomembrane covers on storage areas, installation of dust collection or suppression systems on processes and following prescribed preventive maintenance procedures for

processing and control equipment at the facility. Crushed ore that is moved off-site will be transported in covered trucks to minimize dust emissions.

Certain areas of the facility, such as the coarse ore storage area, the crushed ore storage area, ore handling activities, cement/fly ash handling and blending activities and the aggregate feed hopper will all include some type of partial or complete enclosure to reduce emissions of fugitive dust. In addition, crushing activities within the crushing building will be controlled using a combination of wet scrubber and fabric filter baghouse. These controls will be used to minimize emissions of fugitive dust and small amounts of metals that occur in the host material, such as copper and nickel. It is anticipated emissions from the baghouse should be controlled to a level of at least 99%. To ensure proper operation of the baghouse and wet scrubber, each piece of equipment will be subject to a rigorous inspection and maintenance program, including monitoring of pressure drop across bags, monitoring of gas and scrubbing liquid flow, visual observations of stack emissions to assess opacity and periodic maintenance of individual components of the equipment. To minimize the potential for fugitive dust during transport of crushed ore material, each ore truck will be covered with a secure cover to reduce the possibility of dust being evolved during transportation of the material.

Emissions of nitrogen dioxide from diesel-fired generators will be controlled through use of selective catalytic reduction (SCR) devices that will be installed on each of the three generator units. When in use, these devices have the potential to reduce nitrogen dioxide emissions by 90%. These devices will be operated in a fashion to keep emissions below permissible levels.

Portland cement and fly ash will be used as binder for aggregate material that will be used to backfill primary stope areas underground. The cement and fly ash will be unloaded at the surface and stored temporarily until they are transferred to storage bins located underground. To control potential emissions during offloading, these materials will be unloaded using a truck mounted pneumatic conveying system and will be stored in silos that utilize bin vent controls to minimize dust emissions.

The facility will also utilize certain pieces of mobile equipment to move raw and crushed ore materials about the site. Equipment will include ore production trucks, front end loaders, product haul trucks and miscellaneous delivery trucks. To control dust emissions during movement of these vehicles across the site during dry periods, a comprehensive on-site watering program has been developed to control these potential fugitive sources of dust. A more detailed discussion of the on-site watering program is included in the *Fugitive Dust Control Plan* that was included as Appendix D with the *Michigan Air Use Permit – Permit to Install Application* (Foth & Van Dyke, 2005) for the project. Dust emissions generated underground will be controlled by use of water sprays on certain stationary activities. Dust generated from the movement of mobile equipment will be mitigated through settling of dust throughout mine workings in the underground area and or watering. Additional discussion of this aspect is included in the *Michigan Air Use Permit- Permit to Install Application* (Foth & Van Dyke, 2005) for the project.

To ensure facility-wide emissions during operations will not have a detrimental impact on human health or the environment, all emissions from the facility were evaluated using an air dispersion model in accordance with MDEQ requirements. During evaluation of facility-wide emissions, the maximum emission rate from each step of the operation was included in the air dispersion model. The results of the model indicate that all emissions from operations at the facility,

including the generators, will meet all USEPA and Michigan ambient air quality standards. Included below in Table 3-7 are the results of the maximum impacts for federal criteria pollutants from the modeling study. Included in the table is a comparison of results against federal criteria pollutants for each averaging period with respect to the National Ambient Air Quality Standards (NAAQS). Also provided are the receptor locations and data period for each concentration. More detailed discussion of the results of the air dispersion model can be found in the *Air Quality Impact Analysis Report* that was included as Appendix E of the *Michigan Air Use Permit- Permit to Install Application* (Foth & Van Dyke, 2005) for the Eagle Project.

Table 3-7
Criteria Pollutants
Maximum Predicted Ambient
Concentrations from the Modeling Study

Pollutant	Averaging Period	Maximum Conc'n (µg/m³)	NAAQS (µg/m³)
PM10	Annual	3.01	50
PM10	24-Hr Avg	22.69	150
NO ₂	Annual	14.46	100
SO ₂	Annual	3.45	80
SO ₂	24-Hr Avg	57.14	365
SO ₂	3-Hr Avg	203.45	1,306
CO	8-Hr Avg	52.36	10,000
CO	1-Hr Avg	304.12	40,000
Lead	Calendar Quarter Avg	0.0005	1.5

Prepared by: CED1
Checked by: AKM

In addition to compliance with the federal NAAQS, the facility must also be in compliance with applicable screening levels for identified Michigan Toxic Air Contaminants (TACs). New or modified facilities may not emit identified TACs at levels that would cause a predicted ambient impact in excess of a contaminant specific health based screening level. There are three types of screening levels: the Initial Threshold Screening Level (ITSL), the Initial Risk Screening Level (IRSL) and the Secondary Risk Screening Level (SRSL). To determine compliance with these screening levels, a spreadsheet was obtained from the MDEQ website and used to screen these metals pursuant to the method outlined in R 336.1227(1)(a). Maximum emission rates, obtained from the facility PTE calculations for the *Michigan Air Use Permit- Permit to Install Application* (Foth & Van Dyke, 2005), were listed as Proposed Emission Rates, to assess compliance for each ITSL, IRSL or SRSL. Of the fifteen (15) metals identified in materials that will be crushed on-site, eleven of the metals are in compliance with R 336.1225 based on this approach. The results of this screening analysis are provided in Appendix I-4. The other four (4) were screened using the ISCST3 air dispersion model, pursuant to the approach outlined under R 336.1227(1)(c). The results of the modeling analysis are provided in Table 3-8.

Table 3-8
Comparison of Maximum Source Impacts for Michigan Toxic Air
Contaminants to Appropriate ITSL, IRSL or SRSL Screening Levels

Listed Toxic Air Contaminant ⁽¹⁾	Screening Level (µg/m ³)	Screening Level Averaging Time	Type of Screening Level	Maximum Predicted Ambient Impact (µg/m ³)
Cobalt	0.2	8-Hr Avg	ITSL	0.022
Copper	2.0	8-Hr Avg	ITSL	0.807
Manganese	0.05	24-Hr Avg	ITSL	0.028
Nickel	0.0042	Annual	IRSL	0.00295

(1) Remaining identified TACs are in compliance with all screening levels using the screening tool provided under R 336.1227

Prepared by: CED1

Checked by: AKM

Once underground mining and ore crushing activities are completed at the site, reclamation will commence in accordance with the rules promulgated under R 425.204. Similar to activities described above for construction, it is anticipated that fugitive dust emissions could be released during wind storm events from newly exposed soil and uncovered soil stockpiles. To mitigate these activities, areas that are reclaimed will be re-vegetated to stabilize soil and reduce dust emissions. Temporary stockpiles will be covered to minimize the potential impact of wind blown dust. If severe wind or an excessive rain event reduces the effectiveness of these protective measures, appropriate action will take place as soon as possible to restore vegetated areas to their previous effectiveness and replace covers as necessary.

In summary, engineering controls that are proposed for the Eagle Project, together with the air modeling analysis documented in the *Michigan Air Use Permit- Permit to Install Application* (Foth & Van Dyke, 2005) have demonstrated that the project will comply with applicable USEPA and MDEQ air quality standards. Therefore, no deleterious environmental impacts due to air emissions are expected and no mitigation measures are proposed beyond that which is described above and in the *Air Permit Application* for the site.

3.18 Aesthetic Resources (Visual, Noise, Light, Seismicity)

Aesthetic resources are discussed in the context of potential visual, noise, light, and seismic effects related to mine activities per the requirements of R 425.202(2)(hh) – (kk). In order to evaluate potential aesthetic impacts, potentially sensitive receptors located near the project site are identified and quantified. Potentially sensitive receptors include hospitals, schools, day care centers, cemeteries, parks, universities, and other institutions that have limited tolerance for noise, light, and seismicity. No potentially sensitive receptors have been identified near the project site. The proposed mine location is generally remote from towns and villages in the surrounding area. The nearest town is Big Bay, approximately 10 miles northeast of the project site with a population of 265 according to the 2000 census. Marquette, the upper peninsula's largest town (approximately 20,000), is approximately 25 miles to the southeast. Traffic on the

thoroughfare to the mine, the Triple A Road, will generally be limited to individuals pursuing recreational activities in the area. The road is currently unpaved. There are no public establishments or permanent residences within 1-mile of the mine. As such, public exposure to the mine is based on general public and recreational users passing through the area, viewing the facility as they drive by.

The mine area includes the surface facilities necessary to support the mining operation. Figure 2-3 and Figure 3-3 shows the features of the site. There are two separate areas shown: the main surface facility which contains most of the processing equipment, offices, TDRSA, and mine portal; and the backfill site, a small site containing surface backfill silos and the main ventilation air raise (MVAR). Triple A Road is the only public road from which both parts of the mine area can be accessed.

3.18.1 Potential Impacts Visual

Main Facility

The main surface facility will be set back from the road on the north side of Triple A Road. This location provides several options for mitigating the view from the road. The facility access road from Triple A is approximately 660 feet long. It directs vehicles north from Triple A Road, then west to enter the facility. To provide screening, KEMC proposes constructing a berm with the excess soil from the construction of the containment structures and storm water management features shown on Figure 2-3. The berm will almost surround the main facility. Preliminarily, the berm will be approximately 15 feet high based on 200,000 yd³ soil becoming available from the site grading. The visual corridors to the main facility are screened from view by natural features including the bedrock outcrop, woods, and brush. The mine portal (entrance to the underground portion of the mine) is the closest main facility mine component to Triple A Road, located approximately 230 feet north of the road. The berm blocks the view of mine portal and the vehicles entering and exiting the portal. This pile will be visible from Triple A Road when present.

Most of the trees that border the main facility are conifers so screening should be consistent throughout the year. As a westbound vehicle travels along Triple A, the top portions of some of the buildings might be visible as will be several of the taller stacks, including those for the generators and crusher building.

Backfill Facility

The aboveground mine backfill facilities are located on the small site west of the main facility and south of Triple A Road as shown on Figure 2-3. The site is close to the Triple A Road, in a narrow strip of land between the road and the Salmon Trout River. The site structures include two silos storing cement and fly ash, an aggregate stockpile, an NCWIB, and the exhaust fan housing and 49 foot stack for the MVAR. The site will be surrounded by fencing. Because the site is fairly close to the road and the structures are tall, fencing and plantings will block only ground level detail and activities from view.

3.18.2 Potential Noise Impacts

The mine operations will produce noise during project construction and routine operating activities. During the construction phase, heavy equipment operation will produce noise. During routine operation, vehicular traffic, material handling, crushing operation, and the MVAR

exhaust will produce noise. The crushing operation will take place within a building, subduing this noise source. The berm will mitigate routine operation noise from the main facility.

With a lack of potentially sensitive noise receptors, noise impacts are anticipated to be minimal. No local flora or fauna have been identified to be potentially affected by the anticipated facility noise.

3.18.3 Potential Light Impacts

Both the main facility and the small site will be constructed with lighting generally suitable for an industrial facility. KEMC intends to operate two shifts which, coupled with shortened daylight hours in winter, necessitates adequate lighting for safe operation. Ground activities taking place at the backfill facility will also need adequate lighting.

Although the mine operations will require lighting, the mine is in a remote location which lacks additional light sources and potentially sensitive light receptors. Light impacts are expected to be minimal. No local flora or fauna have been identified to be potentially affected by the anticipated facility lighting.

3.18.4 Potential Seismicity Impacts

Seismic activity may be generated by blasting operations, vehicular traffic, and heavy equipment movement during the construction phase. The vehicular traffic and heavy equipment movement will be as expected for an industrial facility. Blasting is planned during the development of the mine and during ore extraction process. Blasting is expected approximately 2 times during operational days. Each blast will have a duration of approximately 3 seconds. Public complaints from blasting activities have generally centered on surface mine or quarry blasting from which vibrations can more easily travel to the surrounding public. For underground mines such as the proposed KEMC Eagle Project, the vibrations will be naturally attenuated. The mine levels vary from 60 m below the surface to almost 300 m below the surface. Air vibration should be dampened to imperceptible levels at the surface. Furthermore the area surrounding the mine is sparsely populated, as such, air vibration issues will not be a concern for this mine. The nearest permanent residence to the mine is over five miles away and the nearest seasonal camp is over one mile from the site. As such, seismic impacts to public or private structures will not occur. No local flora or fauna have been identified to be potentially affected by the weak seismic events caused by underground blasting for a period of several seconds each day. As discussed, surface vibration will be attenuated due to the elastic nature of the soils.

4 Alternatives Evaluation

This section provides an evaluation of feasible and prudent alternatives for key mining activities, in accordance with R 425.202(1)(c). The following features of the Eagle Project were considered for this alternatives evaluation:

- ♦ Mining method
- ♦ Ore Processing
- ♦ Transportation
- ♦ Power supply
- ♦ Surface facilities location
- ♦ Treated water discharge, and
- ♦ End use

For each of these major components of the project, the alternatives evaluation includes a description of feasible and prudent alternatives, a description of alternatives considered but not carried forward for further evaluation and a description of why the chosen alternatives are preferred.

4.1 Mining Method

Early in the evaluation of the Eagle Project, various mining methods were considered, taking into account environmental impacts and economics. Generally, the choice of mining methods depends on the geological and geotechnical characteristics of the ore body, the type of country rock and the depth of overburden, taking into consideration environmental impacts and overall economics. The mine production capability generally depends on the selected mining method and the geometry of the ore body, which generally drives economics.

A preliminary assessment of open pit mining early on in the evaluation process resulted in a determination that open pit mining would result in a significantly larger environmental footprint and reduced economics. This is primarily related to the depth of the ore body and overburden thickness. Since the ore body is located beneath wetlands and a stream, these existing surface features would have to be relocated in order for the open pit concept to be viable. In addition, the open pit concept would include stripping of overburden soils and stockpiling for reclamation. The footprint of the open pit would be larger than the footprint of the ore body such that additional overburden and country rock would have to be removed to allow for complete removal of the ore due to the development of benches and stepping of the pit sidewalls. This would result in the substantial removal of overburden and development rock. Given the additional disturbance of an open pit mining method, it was dropped from consideration early in the development of the mining concept and the proposed underground methods described in Volume I of this *Mining Permit Application* were selected.

4.2 Ore Processing

Both transportation and ore processing are closely related and influence the overall project operations. This section provides a description of ore processing alternatives. The transportation alternatives are discussed in the next section.

Early in the feasibility evaluation of the Eagle Project, two different ore processing alternatives were considered as follows:

- ♦ Milling and flotation of coarse ore on-site to generate a Ni/Cu concentrate for shipping to an off-site processor.
- ♦ Transport by rail of coarse ore to an off-site mill in Canada.

Because of the resource and capital requirements for a mill on a greenfield site, on-site processing was not selected. The selected alternative for mineral processing includes the direct shipment of the coarse ore to Canada by rail. This decision was made based on the ore grade, transportation requirements and the relatively short timeframe of the project. Direct ship involving intermodal transportation involving trucks, rail and ships is not economical. Direct ship to Canada via trucks is also not an economically viable alternative.

4.3 Transportation

As discussed in the previous section, ore processing and transportation are closely related. For the evaluation of transportation alternatives, it was assumed that ore primary crushing at the mine site. From the mine site, coarse ore would then be transported by truck on approved county roads to a yet to be identified railhead site near Marquette. From the railhead, coarse ore will be shipped by rail to a mill in Canada.

Once the decision was made to transport crushed ore from the mine site to a railhead, an evaluation of alternative transportation routes was undertaken. Several transportation routes and railhead locations were screened, based on the overall condition of the roadway and infrastructure (subgrade conditions, drainage, bridges, etc.). Overall costs to upgrade portions of the route, along with potential environmental concerns were also considered in this evaluation. Five alternative routes were evaluated, as shown in Figure 2-6, and described below:

- ♦ Triple A Road to Peshekee Grade – Transport the ore via the Triple A Road to Peshekee Grade to a railhead in Michigamme Township. Dropped due to road improvement costs.
- ♦ CR 510 Option - Triple A Road → CR 510-Midway Drive → US 41 to a railhead in the vicinity of Marquette. This option was not selected as the best option based on initial construction improvement requirements and trucking costs.
- ♦ Logging Road Option - Triple A Road → CR 510 → Private Logging Road → CR550 → to a railhead in the vicinity of Marquette. This option was not selected as the best option based on initial construction improvement requirements.
- ♦ CR 550 Option - Triple A Road → CR 510 → CR 550 → to a railhead in the vicinity of Marquette. This route is the recommended alternative.
- ♦ The south transportation route - Create a road to a railhead in the vicinity of Highway 41. This option is dependent on the successful negotiation of road easements with private land owners. This option is not feasible due to lack of connecting easements at this time although discussions are ongoing.

Based on a detailed review of overall economics, the preferred choice of transportation was identified as the “550 option”, as described above. The evaluation considered capital improvements required to the Triple A Road and portions of the CR 510. Maintenance costs such as snow removal were also taken into consideration.

4.4 Power Supply

Facility power will be provided by a set of three diesel generators, each capable of delivering 1825 kW of power. Each generator will be equipped with selective catalytic reduction (SCR) units installed on individual exhaust stacks. SCR units can reduce the concentration of NO_x in the generator exhaust by 90%.

Three generators will be provided, however, only two will be operating at any given time. This provides redundancy and regular periods of downtime for maintenance. The generators will be operated equally throughout the year with relatively equal loading, depending on maintenance requirements. The maximum routine power needed during full mine operation will be approximately 2.6 mW. The generators will be fueled with low sulfur, No. 2 diesel-fuel with a sulfur content of less than 0.5%.

Heat for the mine ventilation system will be supplied by waste heat from the diesel generators augmented by heat from propane fired heaters, as needed to raise the mine intake air to above 32 degrees F.

The alternative to on-site generators would be to bring electric power to the site from the nearest grid connection. Key criteria used in the evaluation of the electrical power supply to the site included the following:

- ♦ Life of the project
- ♦ Capital costs
- ♦ Operating costs
- ♦ Reliability, and
- ♦ Environmental impact

The location of the nearest connection to an electric transmission line is as follows:

- ♦ Twenty-eight miles south to a three phase line near Champion.
- ♦ About 13 miles to a single-phase line that services Big Bay.

The single phase-line will not meet the needs of the project. Given the relatively short duration of the project and the distance to the grid connection point near Champion, the most sensible alternative was determined to be use of on-site generators. Reliability will be provided by having a backup generator available, as discussed above.

Natural gas-fired or propane generators are also commercially available. Due to the lack of natural gas pipelines in the area, this alternative was not considered to be viable. Propane, like diesel would have to be trucked to the mine site. Due to the higher capital and operations of propane operations, cost of diesel fired generators was selected over propane-fired units. Environmental impacts will be minimized by the addition of SCR units and through the use of low sulfur diesel fuel.

4.5 Location of Surface Facilities

The location of the surface facilities are shown on Figure 2-3.

The location of the surface facilities was selected, based on the following primary considerations:

- ♦ Accessibility and proximity to the mine
- ♦ Avoidance of direct impacts to wetlands
- ♦ Minimization of surface disturbance including site grading and vegetation
- ♦ Minimizing visibility from the Triple A road, and
- ♦ Accessibility to off site transportation routes

The selected location for the surface facilities became quite obvious once the access to the mine and portal location were selected based on the mining method and overall mine layout. Potential locations to the south of the portal would be more visible from the Triple A Road. The selected location provides good accessibility from the mine and Triple A road, while minimizing environmental disturbance associated with the surface facilities.

4.6 Treated Water Discharge

The Eagle Project will have an extensive water management program. Mine water streams will be generated during construction, operation, and closure of the Eagle Project. The main water management facilities include the CWBs, the WWTP, and the TWIS.

The primary alternative to discharging wastewater to groundwater would be direct discharge to a surface water body. The receiving water would likely be the Salmon Trout River, located to the south of the surface facilities.

The alternative for discharge of treated water to surface water was evaluated, but considered less than optimal because of the overall water balance concerns. Since most of the treated water is expected to come from groundwater inflow to the mine, infiltration back into the groundwater system is the preferred discharge option. Another goal of the overall water balance strategy is to minimize acute alteration of aquatic habitats caused by a point source discharge to surface water.

4.7 End use

The final land use of the Eagle Project property will be open green space and areas of natural vegetation. The proposed land use is consistent with surrounding land uses and is also consistent with local zoning. The goal of the current end use plan is to promote a diverse plant community and provide habitat for a variety of indigenous wildlife species, similar to pre-mining conditions.

As an alternative to the selected end use, KEMC may choose to establish a passive recreational end use for all or portions of the property that would also be consistent with surrounding land uses and is self sustaining. If KEMC decides to promote recreational uses for site after mining and reclamation, additional discussion with the local government, public, MDEQ and MDNR will occur prior to requesting this change.