Volume 5-Chapter 10

NATURAL, SCIENTIFIC, AND HISTORICAL AREAS

Minnesota Environmental Quality Board
Regional Copper-Nickel Study
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REGIONAL COPPER-NICKEL STUDY REPORT OUTLINE

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A NOTE ABOUT UNITS

This report, which in total covers some 36 chapters in 5 volumes, is both international and interdisciplinary in scope. As a result, the problem of an appropriate and consistent choice of units of measure for use throughout the entire report proved insurmountable. Instead, most sections use the system of units judged most common in the science or profession under discussion. However, interdisciplinary tie-ins complicated this simple objective, and resulted in the use of a mix of units in many sections. A few specific comments will hopefully aid the reader in coping with the resulting melange (which is a reflection of the international multiplicity of measurement systems):

1) Where reasonable, an effort has been made to use the metric system (meters, kilograms, kilowatt-hours, etc.) of units which is widely used in the physical and biological sciences, and is slowly becoming accepted in the United States.

2) In several areas, notably engineering discussions, the use of many English units (feet, pounds, BTU's, etc.) is retained in the belief that this will better serve most readers.

3) Notable among the units used to promote the metric system is the metric ton, which consists of 2,205 pounds and is abbreviated as mt. The metric ton (1,000 kilograms) is roughly 10% larger (10.25%) than the common or short ton (st) of 2,000 pounds. The metric ton is quite comparable to the long ton (2,240 pounds) commonly used in the iron ore industry. (Strictly speaking, pounds and kilograms are totally different animals, but since this report is not concerned with mining in outer space away from the earth's surface, the distinction is purely academic and of no practical importance here).

4) The hectare is a unit of area in the metric system which will be encountered throughout this report. It represents the area of a square, 100 meters on a side (10,000 m^2), and is roughly equivalent to $2\frac{1}{2}$ acres (actually 2.4710 acres). Thus, one square mile, which consists of 640 acres, contains some 259 hectares.

5) Where electrical energy is converted to thermal units, a conversion factor of 10,500 BTU/kWH is used. This means that the energy lost to waste heat in a central power plant is included, assuming a generating efficiency of 32.5%.

The attached table includes conversion factors for some common units used in this report. Hopefully, with these aids and a bit of patience, the reader will succeed in mastering the transitions between measurement systems that a full

reading of this report requires. Be comforted by the fact that measurements of time are the same in all systems, and that all economic units are expressed in terms of United States dollars, eliminating the need to convert from British Pounds, Rands, Yen, Kawachas, Rubles, and so forth!

Conversions for Common Metric Units Used in the Copper-Nickel Reports

1 meter (m)	=	3.28 feet = 1.094 yards
1 centimeter (cm)	=	0.3937 inches
1 kilometer (km)	=	0.621 miles
1 hectare (ha)	=	10,000 sq. meters = 2.471 acres
1 square meter (m^2)	=	10.764 sq. feet = 1.196 sq. yards
1 square kilometer (km^2)	=	100 hectares = 0.386 sq. miles
1 gram (g)	=	0.037 oz. (avoir.) = 0.0322 Troy oz.
1 kilogram (kg)	=	2.205 pounds
1 metric ton (mt)	=	1,000 kilograms = 0.984 long tons = 1.1025 short tons
1 cubic meter (m^3)	=	1.308 yd^3 = 35.315 ft^3
1 liter (l)	=	0.264 U.S. gallons
1 liter/minute (l/min)	=	0.264 U.S. gallons/minute = 0.00117 acre-feet/day
1 kilometer/hour (km/hr)	=	0.621 miles/hour
1 kilowatt-hour (kWH)	=	10,500 BTU (for production of electricity at 32.5% conversion efficiency)
degrees Celsius (^oC)	=	(5/9)(degrees Fahrenheit -32)

Standard Abbreviations.

ha - hectare
st - short ton of 2,000 lb
lt - long ton of 2,240 lb
mt - metric ton of 2,205 lb
mtpy - metric ton(s) per year

ppm - parts per million
ppb - parts per billion
um - micron or 10^{-6} meters
% - percent by weight unless otherwise noted

ELEMENT	SYMBOL	ELEMENT	SYMBOL	ELEMENT	SYMBOL
Actinium	Ac	Holmium	Ho	Rhenium	Re
Aluminum	Al	Hydrogen	H	Rhodium	Rh
Americium	Am	Indium	In	Rubidium	Rb
Antimony	Sb	Iodine	I	Ruthenium	Ru
Argon	Ar	Iridium	Ir	Samarium	Sm
Arsenic	As	Iron	Fe	Scandium	Sc
Astatine	At	Krypton	Kr	Selenium	Se
Barium	Ba	Lanthanum	La	Silicon	Si
Berkelium	Bk	Lawrencium	Lw	Silver	Ag
Beryllium	Be	Lead	Pb	Sodium	Na
Bismuth	Bi	Lithium	Li	Strontium	Sr
Boron	B	Lutetium	Lu	Sulfur	S
Bromine	Br	Magnesium	Mg	Tantalum	Ta
Cadmium	Cd	Manganese	Mn	Technetium	Tc
Calcium	Ca	Mendelevium	Md	Tellurium	Te
Californium	Cf	Mercury	Hg	Terbium	Tb
Carbon	C	Molybdenum	Mo	Thallium	Tl
Cerium	Ce	Neodymium	Nd	Thorium	Th
Cesium	Cs	Neon	Ne	Thulium	Tm
Chlorine	Cl	Neptunium	Np	Tin	Sn
Chromium	Cr	Nickel	Ni	Titanium	Ti
Cobalt	Co	Niobium	Nb	Tungsten	W
Copper	Cu	Nitrogen	N	Uranium	U
Curium	Cm	Nobelium	No	Vanadium	V
Dysprosium	Dy	Osmium	Os	Xenon	Xe
Einsteinium	Es	Oxygen	O	Ytterbium	Yb
Erbium	Er	Palladium	Pd	Yttrium	Y
Europium	Eu	Phosphorus	P	Zinc	Zn
Fermium	Fm	Platinum	Pt	Zirconium	Ar
Fluorine	F	Plutonium	Pu		
Francium	Fr	Polonium	Po		
Gadolinium	Gd	Potassium	K		
Gallium	Ga	Praseodymium	Pr		
Germanium	Ge	Promethium	Pm		
Gold	Au	Protactinium	Pa		
Hafnium	Hf	Radium	Ra		
Helium	He	Radon	Rn		

Volume 5-Chapter 10 NATURAL, SCIENTIFIC AND HISTORICAL AREAS

10.1 INTRODUCTION AND SUMMARY OF FINDINGS

Several sites in the Study Area have been identified by various federal, state, and private agencies as possessing natural or cultural features which warrant protection, should receive restricted use, or are to be used for research purposes (Figure 1). Historic, natural, and scientific areas preserve knowledge of historic values, protect rare species and unique biological communities, and retain examples of the natural characteristics of the land. This chapter examines the location, uses, sensitivity, and legal status of these areas in order to identify land use conflicts with potential copper-nickel mining activities. Copper-nickel development could alter or detract from the use of several areas directly through consumption of land for mining purposes or indirectly through changes in air quality, water quality, noise, and residential development.

Most of the sites in the Study Area which have been identified or designated as historic, natural, or scientific resource areas are located outside the range of potential direct copper-nickel impacts. The scientific and natural areas that would be subject to displacement by copper-nickel mining facilities are located in zones 1 and 2, and one historic site is located in zone 6. Of these areas, the BWCA and Keeley Creek Research Natural Area are presently protected by state and federal laws and regulations from direct intrusion by mining development. The protection of these areas from indirect impacts and from impacts caused by development located outside of these areas is unclear. All the sites are isolated and could be avoided by mining development; therefore, siting would be a major mitigating factor.

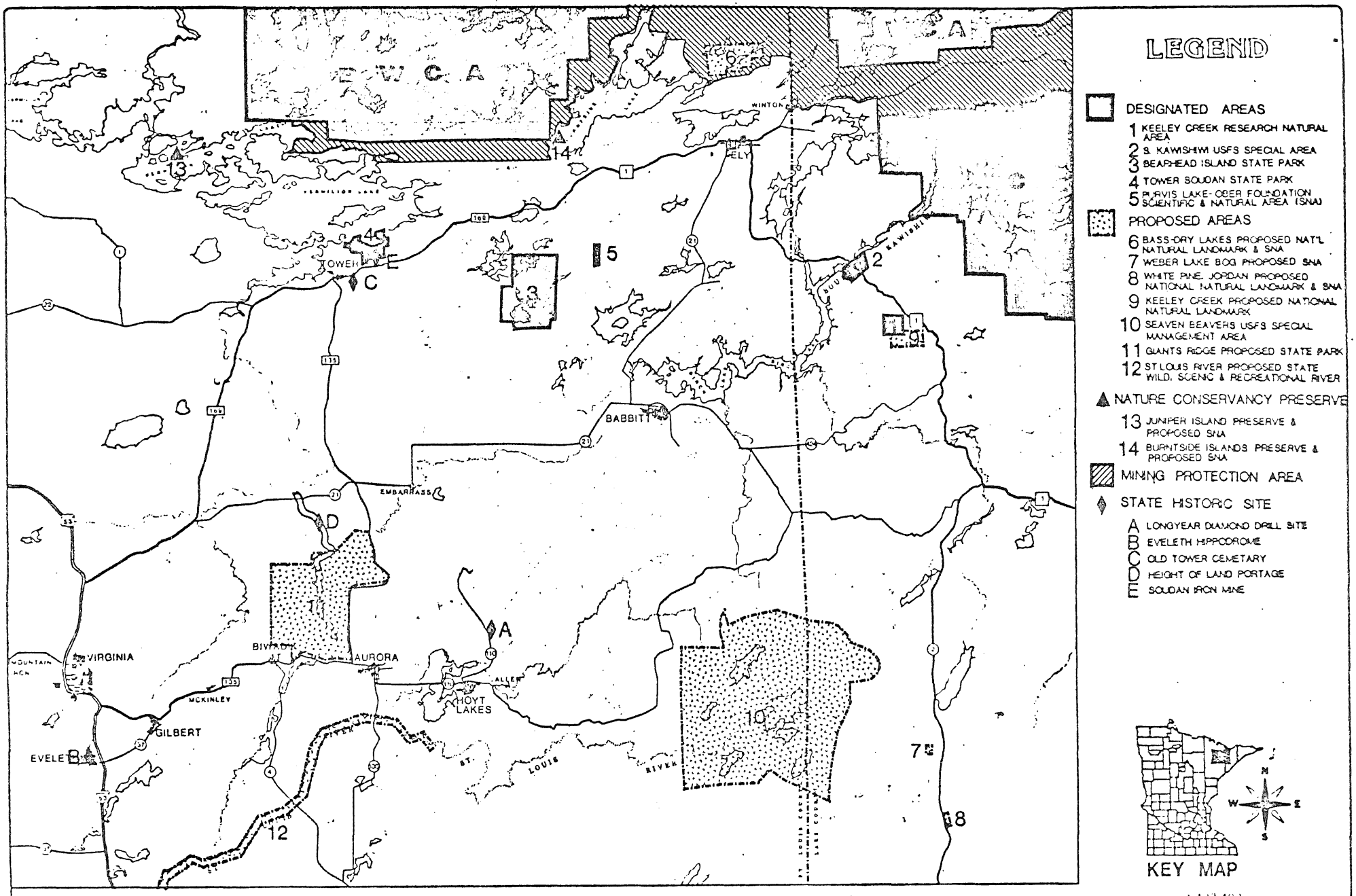


FIGURE 1

MEQB REGIONAL COPPER-NICKEL STUDY

NATURAL, SCIENTIFIC AND HISTORICAL AREAS

Copper-nickel development would cause significant changes in the quality of water resources in watersheds downstream from the area developed. Development north of the Laurentian Divide (zones 1-3 and part of 4) could affect the quality of water entering the BWCA. A small portion of zone 1 would have the greatest potential impact as it lies within a watershed flowing directly into the BWCA. The South Kawishiwi River Special Area could also be impacted by copper-nickel waste waters from development in zones 1 and 2. During the operational phase, it would be possible to maintain background stream concentrations through reduction of discharge and/or extensive treatment, but this may not be possible during the post-productive phase.

Most scientific and natural areas would not be significantly impacted by air quality changes resulting from copper-nickel development if the developments are designed and operated so that they conform with present state and federal air quality regulations. Because of their proximity to or location within the development zones, the BWCA, the Keeley Creek Research Natural Area, and the South Kawishiwi River Special Area would be susceptible to air quality impacts although the BWCA is presently protected by federal law from significant air quality changes. Impacts resulting from air quality changes could essentially be eliminated by the use of adequate pollution control systems and/or careful siting of facilities.

10.2 CHARACTERIZATION OF HISTORIC, NATURAL, AND SCIENTIFIC RESOURCE AREAS

Several federal, state, and private agencies are presently involved in the identification, acquisition, and designation of historic, natural, and scientific resources. The classification programs that deal with these areas differ by name, criteria, management, and legal protection. This report considers only

sites in the Study Area that have been designated or proposed for designation to these programs. Additional areas of equal or greater importance may only be located during more exhaustive inventories and site specific studies.

10.2.1 Historic and Archeological Sites

The Minnesota State Historic Preservation Office (within the Minnesota Historical Society) maintains an inventory of historic and prehistoric places. This inventory is the basis for nominations presented to the National Register of Historic Places. Five historic sites in the Study Area are included in this inventory. Of these sites, the Soudan Iron Mine is also on the National Register of Historic Places and Height of Land Portage is presently (summer 1978) under consideration for the National Register.

An archeological site must be located on land owned or leased by the state, county, township, or municipality to qualify as a state archeological site. In order to protect and preserve archeological objects, only the state archeologist and persons licensed by the Director of the Minnesota Historical Society may do fieldwork on state sites. All sites in the Study Area are historic archeological sites. To date no prehistoric archeological sites have been found, although some may exist within 1000 feet of permanent waters (Lofstrom 1977). Location of the nine sites in the Study Area are generalized to prevent unauthorized excavation.

All historic and archeological sites in the Study Area (Table 1) share the same legal protection under the Federal Archeological and Historical Preservation Act of May, 1974 (93-291) which requires careful study of the resource prior to federally financed development. Federal law also requires that dam construction or licensing for dam construction must be preceded by study if a proposed reservoir will be larger than forty acres, or if a known historic resource exists in

the area to be flooded. Minnesota Statutes (Ch. 138) require cooperation with the Historical Society to safeguard these resources.

Table 1

10.2.2 Natural and Scientific Areas

The Study Area includes parts of the Superior National Forest, five State Forests, and two County Memorial Forests. There are numerous scientific and natural resources found within these Forests and on adjacent private property. For the purposes of this report, only those areas recognized by or nominated to one of the following programs have been identified (Tables 2 and 3).

Table 2 and 3

10.2.2.1 Research Natural Area of U.S. Land Holding Agencies--On the recommendation of the forest supervisor or the regional forester "the Chief (Forest Service) shall establish a series of research natural areas, sufficient in number and size to illustrate adequately or typify for research or educational purposes, the important forest and range types in each forest region, as well as other plant communities that have special or unique characteristics of scientific interest and importance. Research Natural Areas will be retained in a virgin or unmodified condition except where measures are required to maintain a plant community which the area is intended to represent. Within areas designated by this regulation, occupancy under a special-use permit shall not be allowed, nor the construction of permanent improvements permitted except improvements required in connection with their experimental use, unless authorized by the Chief of the Forest Service." (30 Stat. 35, amended, 16 U.S.C. 551)(31 F.R. 5072, March 29, 1966)

Table 1. Historical and archeological sites.

	SITE	LOCATION
State Historic Sites	Soudan Iron Mine (on National Register of Historic Places)	T.62, R.15, S.27; SW1/4
	Longyear Diamond Drill Site	T.59, R.14, S.33; NE1/4, NE1/4
	Old Tower Cemetery	T.62, R.15, S.31; SW1/4, SW1/4
	Eveleth Hippodrome	Eveleth
	Height of Land Portage	T.59, R.15, S.6, 7, 18 T.60, R.15, S.31 T.60, R.16, S.36 & 25
State Archaeological Sites	Pike Bay Mound	T.61, R.16
	Lundstrom	T.62, R.16
	Pearson	T.62, R.16
	Huttala Mounds	T.62, R.16
	Hammas	T.61, R.16
	Soudan Mound	T.62, R.15
	Unnamed	T.61, R.16
	Unnamed	T.62, R.16
	Esquagama Mounds	T.58, R.16

SOURCE: Minnesota Historical Society, 1978.

TABLE 2

NATURAL AND SCIENTIFIC RESOURCE AREA DESIGNATED SITES

SITE	DESIGNATION	SIGNIFICANT CHARACTERISTICS							CURRENT USE			PROTECTIVE STATUS			
		RETAINS NATURAL CHARACTER	UNIQUE OR RARE VEGETATION	UNIQUE OR RARE ANIMALS	VEGETATION REPRESENTITIVE OF REGION	GEOLOGIC FEATURES	HISTORIC OR ARCHEOLOGICAL FEATURES	EXPERIMENTAL STATION	PRESERVATION	RESEARCH	RECREATION	NO LEGAL PROTECTION	RECOGNITION IN ONLY	FEDERAL FUNDING RESTRICTIONS	NO SPECIAL USE, OCCUPANCY OR DEVELOPMENT PERMITTED
BOUNDARY WATERS CANOE AREA	NATIONAL WILDERNESS AREA	■		■	■	■			■	■	■				
KEELEY CREEK (T61, R11, SEC. 14)	USFS RESEARCH NATURAL AREA	■		■	■				■	■					
SOUTH KAWISHIWI SPECIAL AREA (ADJACENT TO HWY 1)	USFS SPECIAL AREA				■			■		■		■			
PURVIS LAKE-OBER FOUNDATION (T62, R13, SEC. 28, SW1/4 OF NW1/4, W1/2 OF SW1/4; SEC. 33, NW1/4 OF NW1/4)	STATE SCIENTIFIC AND NATURAL AREA	■	■	■					■	■					
BEARHEAD STATE PARK	STATE PARK	■									■				
TOWER SOUDAN STATE PARK	STATE PARK					■					■				
BURNTSIDE ISLANDS (T63, R13W)	NATURE CONCERVANCY PRESERVE				■	■									
JUNIPER ISLAND	NATURE CONSERVANCY PRESERVE														

SOURCE: SEE REFERENCES CITED

TABLE 3

NATURAL AND SCIENTIFIC RESOURCE AREAS

PROPOSED SITES

SITE	DESIGNATION	SIGNIFICANT CHARACTERISTICS						CURRENT USE				PROPOSED USE			CURRENT PROTECTIVE STATUS		PROPOSED PROTECTIVE STATUS				STAGE OF PROPOSAL			
		RETAINS NATURAL CHARACTER	UNIQUE OR RARE VEGETATION	UNIQUE OR RARE ANIMALS	VEGETATION REPRESENTATIVE OF REGION	GEOLOGICAL FEATURES	HISTORICAL OR ARCHEOLOGICAL FEATURES	PRESERVATION	RESEARCH	RECREATION	MINING	PRESERVATION	RESEARCH	RECREATION	NO PROTECTIVE STATUS	NO DEVELOPMENT PERMITTED	NO PROTECTIVE STATUS	RECOGNITION IN E.I.S. ONLY	FEDERAL FUNDING RESTRICTIONS	NO SPECIAL USE OCCUPANCY OR DEVELOPMENT PERMITTED	NOMINATION ONLY	EVALUATIVE STUDIES UNDER NEGOTIATION	UNDERGOING EVALUATION	RANKED ON ACQUISITION & DESIGNATION PLAN
BASS-DRY LAKES AREA (T.63. R.12. PARTS OF SEC. 2.3.4.9.10)	PROPOSED NATIONAL NATURAL LANDMARK																							
	PROPOSED STATE SCIENTIFIC & NATURAL AREA																							
WHITE PINE. JORDAN (T.57. R.10. SEC. 18)	PROPOSED NATIONAL NATURAL LANDMARK																							
	PROPOSED STATE SCIENTIFIC & NATURAL AREA																							
JUNIPER ISLAND NATURE CONSERVANCY PRESERVE (T.63. R.17. SEC. 36. LOT 5)	PROPOSED STATE SCIENTIFIC & NATURAL AREA																							
BURNTSIDE ISLANDS NATURE CONSERVANCY PRESERVE (T.63. R.13. PARTS OF SEC. 29 & 30)	PROPOSED STATE SCIENTIFIC & NATURAL AREA																							
EMBARASS MOUNTAIN (T.59. R.15-16 W)	PROPOSED STATE SCIENTIFIC & NATURAL AREA																							
ST. LOUIS RIVER (DOWNSTREAM FROM S.N.F. BOUNDARY)	PROPOSED STATE WILD. SCENIC & RECREATIONAL RIVER																							
KEELEY CREEK (T.61. R.11. SEC. 14. S. 13-S 1/4, SEC. 23-N.E. 1/4. SEC. 24-N 1/2)	PROPOSED NATIONAL NATURAL LANDMARK																							
WEBER LAKE BOG (T.58. R.11. SEC. 36)	PROPOSED STATE SCIENTIFIC & NATURAL AREA																							
GIANTS RIDGE	PROPOSED STATE PARK																							
SEAVEN BEAVERS AREA	U.S.F.S. SPECIAL MANAGEMENT AREA (DISPERSED RECREATION AREA)			●																				

SOURCE: SEE REFERENCES CITED

The Keeley Creek Research Natural Area (T.61, R.11, S.14) is the only such site found in the Study Area. This area is used for long-term research studies on forest succession (among other research uses) and for preservation of the area in a natural state. Although mining development on this site is unlikely, there is no guaranteed protection for this area because "there is no direct legislative protection afforded to a Research Natural Area, by virtue of its designation as such, regardless of which agency makes the designation. Any landholding agency can establish or disestablish a Research Natural Area through its own administrative process; there is no legislation involved in these activities" (The Nature Conservancy 1975).

10.2.2.2 USFS Special Area--Areas within the National Forest designated by Congress, the Secretary of Agriculture, Chief of the Forest Service, or the Regional Forester as possessing significant scenic, wilderness, geological, scientific, or historic features are managed by the USFS as Special Areas. USFS Special Area is a management designation and has no inherent legal status. Each area is managed with the purpose of protecting the special nature of the area. The South Kawishiwi River Special Area is managed as a special area because the North Central Forest Experimental Station and South Kawishiwi Campgrounds are located there. Keeley Creek Research Natural Area and the BWCA are also classified as Special Areas by the USFS and are managed accordingly.

10.2.2.3 National Register of Natural Landmarks--The National Park Service maintains a register of areas which possess exceptional ecological values or qualities and illustrate the natural history of the United States. Although there is no legal protection for these sites, before development occurs an Environmental Impact Statement (EIS) must recognize the features for which the site was designated. The areas are managed to preserve the sites in their

natural state and enhance educational and scientific values. To date there are no sites in the Study Area on the National Register of Natural Landmarks but three areas, White Pine Jordan (T.57, R.10, S.18), Keeley Creek (T.61, R.11, S.13,14,23,24), and Bass-Dry Lakes (T.63, R.12, S.2,3,4,9,10) are proposed for inclusion on the register.

10.2.2.4 National Wilderness Area--National Wilderness Areas are set aside primarily for the purpose of primitive recreation but also for the preservation of the area for future use as wilderness. Parts of the Boundary Waters Canoe Area (BWCA), a National Wilderness Area, lie within the Study Area. No residences are permitted in wilderness areas except for a few existing lifetime leases. No prospecting permits or mineral leases are issued in the BWCA because they are precluded by the Shipstead-Nolan Act (Rehfield 1977). State and federal laws prohibit mining in the BWCA, unless the Congress has declared a national emergency. The boundaries of the BWCA were recently extended under the Boundary Waters Canoe Area Wilderness Act of October, 1978, and now include several RARE II Roadless Areas previously under study by the USFS. Also, this law established a Mining Protection Area consisting of several road corridors located adjacent to the BWCA. The law restricts mining and authorizes the acquisition of mineral rights by the federal government both in the wilderness and Mining Protection Area. No other federal land controls are involved in the Mining Protection Area.

10.2.2.5 State Scientific and Natural Area--State Scientific and Natural Areas are established to preserve and protect habitats of rare and endangered plants and animals, places of historic or prehistoric interest, and areas with inherent natural, educational, or scientific value. Minnesota Department of Natural Resources (DNR) rules and regulations (NR 300-319) prohibit activities which are inconsistent with preservation of the areas, or educational and scientific

objectives. Recreational activities such as hunting, fishing, camping, picnicking, boating, swimming, and snowmobiling are not permitted.

The Purvis Lake-Ober Foundation (T.61, R.13, S.28,33) is the only designated Scientific and Natural Area in the Study Area. At the present time there are numerous nominations on file at DNR, but most proposals have not been evaluated. These nominations include an inventory of significant sites identified by the Copper-Nickel Study (see Huempfner 1976).

10.2.2.6 State Wild, Scenic, and Recreational Rivers--The purpose of the Minnesota Wild and Scenic Rivers Act of 1973 is to preserve and protect rivers and adjacent lands that possess outstanding scenic, recreational, natural, historical, or scientific qualities. Part of the St. Louis River within the Study Area is proposed by the MDNR as a State Wild Scenic River. Wild and Scenic Rivers must exist in a free flowing state with primitive or largely undeveloped adjacent land. If designated, the river and adjacent land would be managed for preservation and primitive recreation with land acquisition programs and possible scenic easement negotiations.

10.2.2.7 State Parks--State Parks provide a combination of recreational space, natural areas, and historic sites. At present there are two state parks (Tower Soudan and Bearhead) and a proposal for a third park (Giants Ridge) within the Study Area. Recreational activities such as fishing, swimming, camping, and boating are permitted along with research and study. (See Volume 5-Chapter 9, Outdoor Recreation, for more information on recreational activities.) MDNR Rules and Regulations prohibit mining or other non-recreational development on state-owned lands within the park.

10.2.2.8 Private Natural Areas--The Nature Conservancy, a private conservation agency, owns two preserves in the Study Area. These two areas, Burntside Islands (T.63, R.13) and Juniper Island (T.63, R.17), are being preserved for their unique ecological features. The preserves have no governmental protection but currently are proposed as additions to the State Scientific and Natural Areas program.

10.3 TACONITE INDUSTRY EXPANSION

Given present economic conditions, the Copper-Nickel Study assumes that the taconite mining industry within the Study Area will expand between 1977 and the year 2000. (See Volume 5-Chapter 5, Mine Lands.) With taconite expansion, more land will be consumed for mine pits, wasterock stockpiles, tailing basins, reservoirs, and processing facilities. An estimated ultimate pit limit (UPL) for the mining of taconite has been described through a minerals availability study (Marsden 1977). The Regional Copper-Nickel Study staff assumes mining could eventually reach the UPL, and estimates that most auxiliary mining operations will be limited to an area 1½ miles to the south of the UPL and 1½ miles north of the northern limits of the Biwabik Iron Formation.

Two historic sites (the Longyear Diamond Drill site and Eveleth Hippodrome) and the proposed Giants Ridge State Park lie within the taconite expansion zones (Figure 2). Approximately 75 percent of the proposed Giants Ridge State Park is located within the taconite buffer zone and a small portion lies within the UPL. Taconite expansion to the UPL would exclude that area for purposes other than actual mining. Giants Ridge State Park is proposed to include an iron ore open pit mine to represent the history of iron ore mining in the state. The state recognizes in its proposal that provisions would have to be made to accommodate

present and future taconite operations in order to make the two uses compatible. The two historic sites are presently located near taconite operations and lie within or near the UPL. There is the potential for these resources to be disturbed or destroyed if taconite mining occurred in the same location.

Figure 2

10.4 IMPACTS OF POTENTIAL COPPER-NICKEL MINING DEVELOPMENT

A major management goal of natural and scientific areas is the preservation of natural ecological processes and protection from anthropogenic impacts. Copper-nickel development could disrupt the natural processes of these areas directly through appropriation of land for mining purposes and indirectly through changes in air quality, water quality, and residential development, greatly reducing the value of such areas for their designated use. The extent to which a particular area would be impacted depends upon site specific mining proposals and the degree of governmental protection afforded the site. This chapter examined impacts only to those areas that have been identified by federal, state, and private agencies as possessing significant features. Copper-nickel mining could impact other areas of equal or greater importance which have not been recognized by these agencies (see Volume 4-Chapter 2, Terrestrial Biology).

10.4.1 Direct Mining Impact

Since the Regional Copper-Nickel Study was not able to evaluate specific mining proposals, copper-nickel resource and development zones were designated to approximately locate potential copper-nickel mining facilities (Figure 3). If economic factors prevail, copper-nickel mining and processing facilities would probably be located within the six-mile-wide development area. Tailing basins

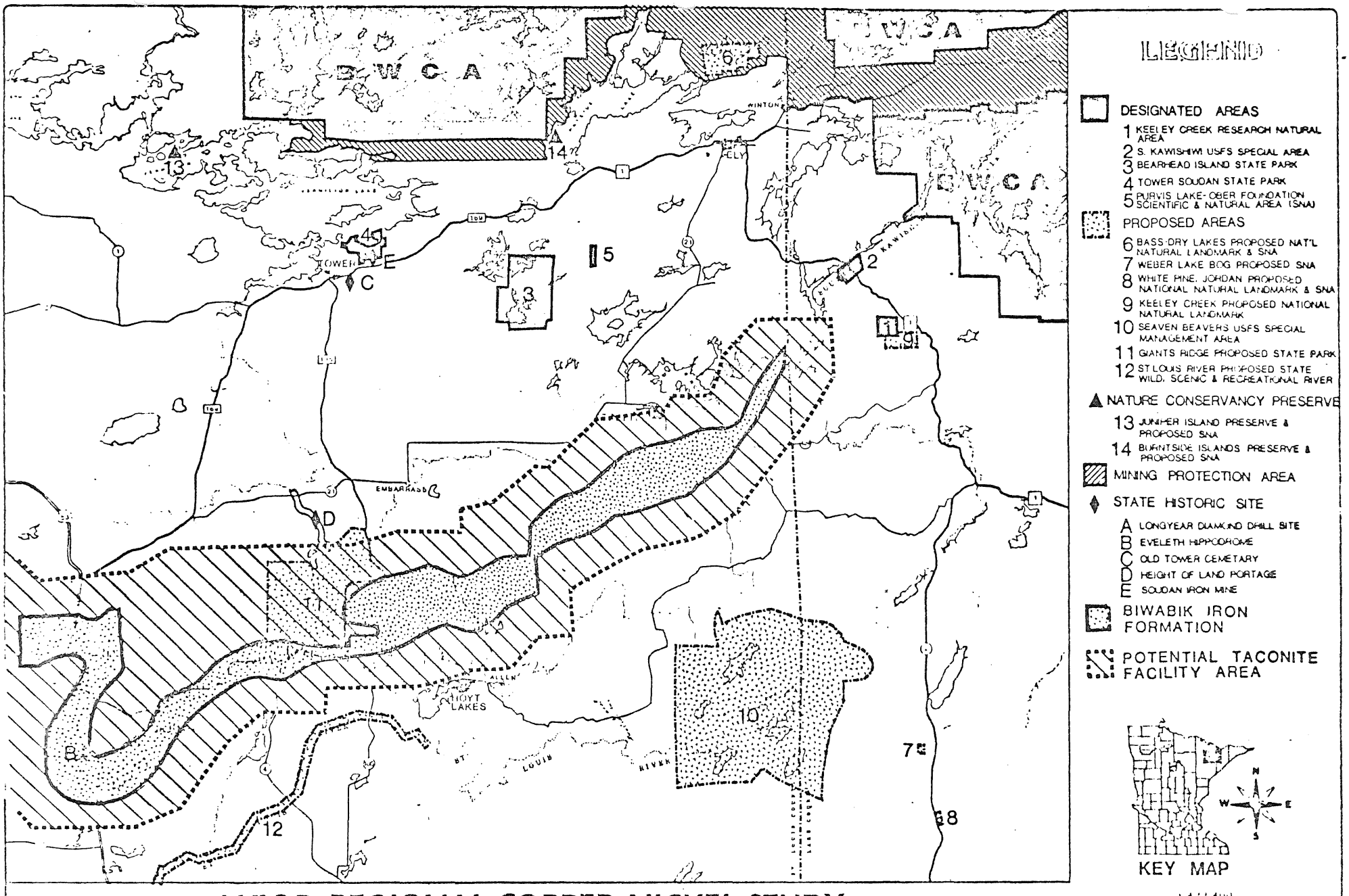


FIGURE 2

MEQB REGIONAL COPPER-NICKEL STUDY

TACONITE EXPANSION ZONES AND NATURAL, SCIENTIFIC AND HISTORICAL AREAS

could be located up to ten miles from the processing plant, but would be located as close to the plant as possible in order to minimize transportation costs.

Figure 3

Most of the natural, scientific, and historic areas are located outside of the copper-nickel development area and would not be subject to displacement by copper-nickel mining development. The sites that are located within the development zones are found in zones 1, 2, and 6. Parts of the BWCA are located in zone 1, and the South Kawishiwi River Special Area and Keeley Creek RNA and proposed National Natural Landmark are found in zone 2. One state historic site, the Longyear Drill Site, is located in zone 6.

Of the areas located within the development zones, the BWCA and Keeley Creek Research Natural Area would be excluded from mining development by state and federal law. The remaining areas, the South Kawishiwi River Special Area and proposed Keeley Creek National Natural Landmark, are not legally protected from mining development and could potentially be displaced by this activity. However, these areas are relatively small in size and isolated and could be avoided by mining development depending on site specific mining proposals.

The South Kawishiwi River Special Area is located directly over identified mineral resources and mineral development in zone 2 could present a direct conflict with this special area. Mine locations are tied to the geological occurrence of economic minerals. Other mining facilities (waste rock/lean ore piles, processing plants, tailing basins, etc.) have flexible siting capabilities which should enable mine planners to avoid special areas. If underground mining is the only mining method utilized in this area, direct conflicts could be

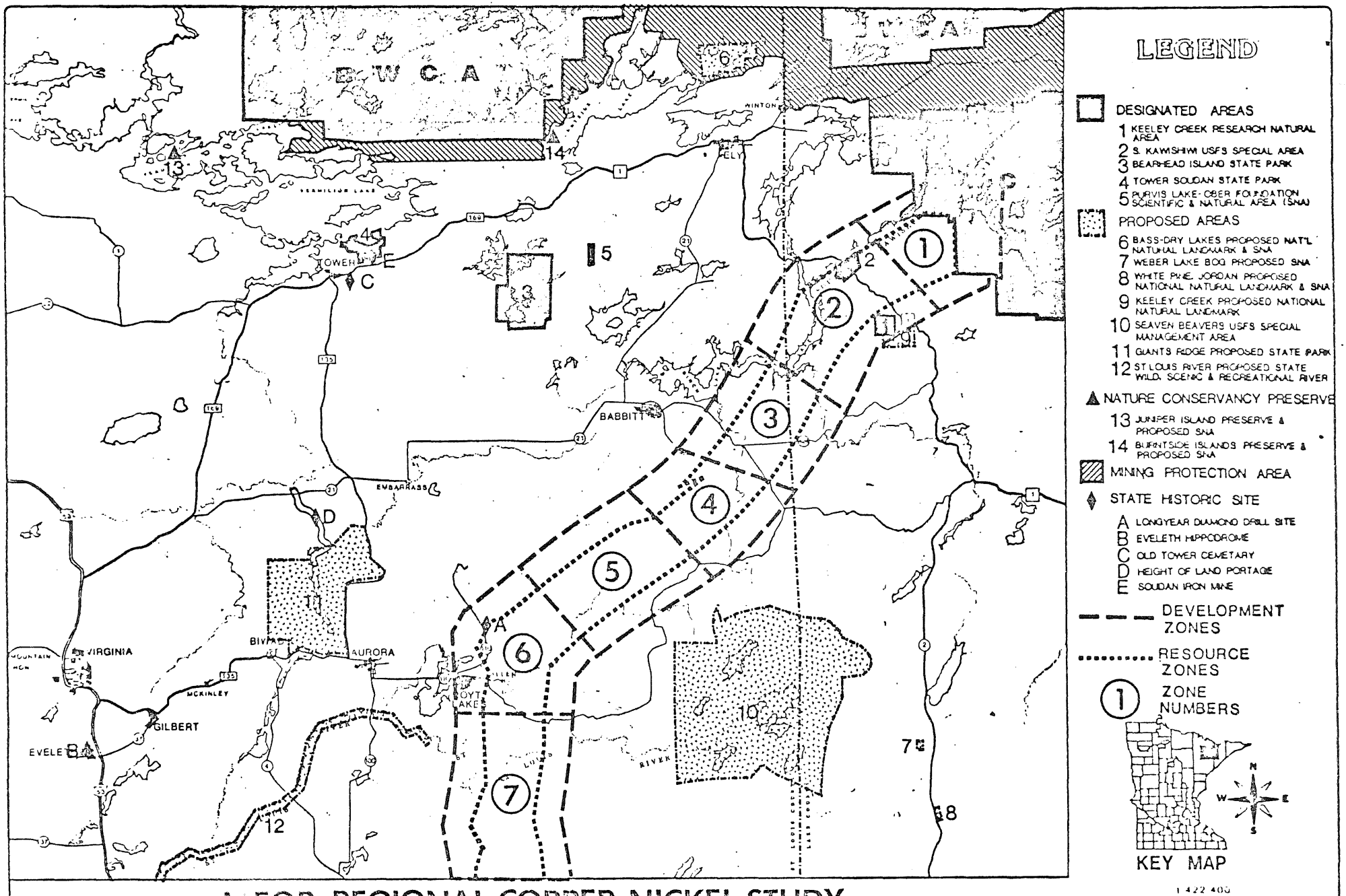


FIGURE 3

MEQB REGIONAL COPPER-NICKEL STUDY

MN CU-NI DEVELOPMENT AND RESOURCE ZONES AND NATURAL, SCIENTIFIC AND HISTORICAL AREAS

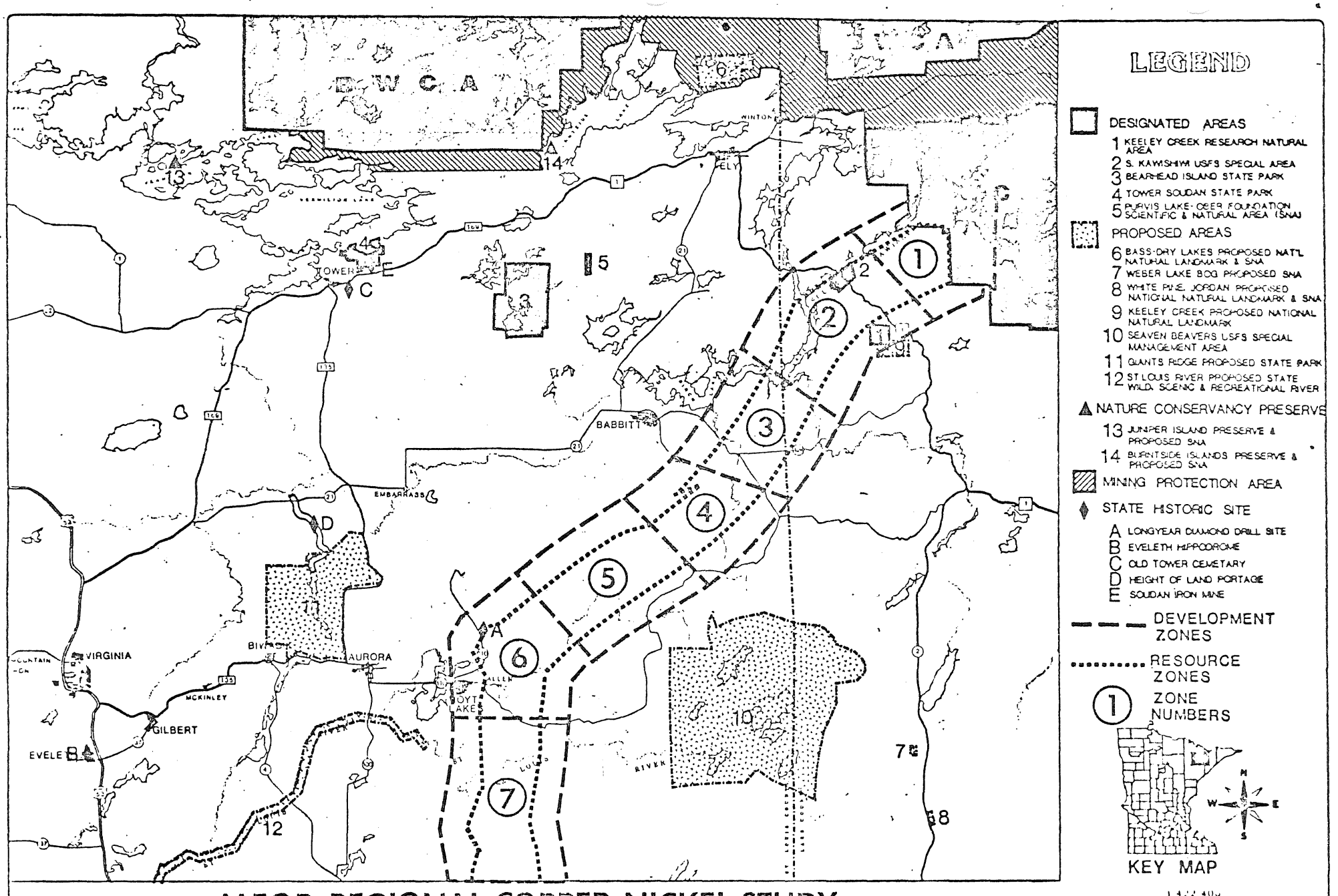


FIGURE 3

MEQB REGIONAL COPPER-NICKEL STUDY

MN CU-NI DEVELOPMENT AND RESOURCE ZONES AND NATURAL, SCIENTIFIC AND HISTORICAL AREAS

avoided. Underground mining is the likely method to be considered in this zone, because the proximity of near surface mineralization to Birch Lake and the South Kawishiwi River will likely preclude open pit methods.

The development of a large underground mine (capable of processing 12.35 million mtpy of crude ore) would require approximately 18 percent of the available land in zone 2. If the South Kawishiwi Special Area and proposed Keeley Creek addition were excluded from mining development, there would still be sufficient land to support underground mining development. Exclusion of the historic site in zone 6 would not significantly reduce the amount of land available for mining. In both zones 2 and 6, specific siting proposals would determine whether the resource would be disturbed or destroyed.

10.4.2 Water Quality Changes

Copper-nickel development will cause significant changes in the quality of water resources in watersheds downstream of the area developed. The magnitude of the change will be dependent upon: 1) the type of mine development, whether open pit or underground; 2) the site characteristics of the development which may either promote or inhibit the effectiveness and economic feasibility of water management systems; and 3) the types and effectiveness of the water treatment system(s) used.

A major management goal of natural, scientific, and wilderness areas is protection from anthropogenic impacts and the preservation of natural ecological processes. Any measurable change in the quality of the water resources in such areas due to human activities could be considered inconsistent with this management goal. This is essentially the criteria that congress has adopted in the Clean Air Act Amendments of 1977 pertaining to significant air quality changes

for wildernes areas and national parks (see Volume 3-Chapter 3, section 3.2.3 for more information on these federal laws and regulations). One method of analyzing the potential for water quality impacts on natural and scientific areas is to use the above management assumption (no measurable change in water quality due to human activities). Although this could be considered an extreme management position, it does provide for a range of resource management and environmental protection policy options when the results are compared to other impact analysis involving recreational resources (Volume 5-Chapter 9) and aquatic ecosystems (Volume 4-Chapter 1).

In order to assess this resource conflict issue, a simplified approach was used; evaluating only two water quality parameters, sulfates (SO_4) and nickel (Ni). While many other parameters in potential point and non-point discharges will be elevated above background conditions, these two parameters address two different water quality control problems and are both projected to be principle constituents of interest in copper-nickel waste waters.

Sulfates are a major product of sulfide mineral chemical weathering (chemical leaching) and are a documented primary constituent of waste water produced by the mining and processing of sulfide minerals (U.S. Environmental Protection Agency 1975). Most sulfates are very soluble in water and require sophisticated and very costly treatment systems for their removal. It is unlikely that such systems would be economically feasible for large-scale application to mining operatons. Therefore, the primary mitigation measures for this pollutant are the elimination of the discharge and dilution of the discharge by receiving waters to levels consistent with the applicable management goal (in this case, within natural variation).

Nickel is toxic to aquatic organisms in trace concentrations and is a primary metal constituent of the mineral resources in question. Research conducted by the Regional Copper-Nickel Study indicates that high concentrations of nickel could occur in discharge waters and that nickel is very mobile in aquatic systems as compared to other metals (e.g. copper) (Volume 3-Chapter 4). Unlike sulfates, nickel can be removed from waste waters using more conventional methods, but if removal to levels approaching background conditions is required, then more sophisticated and costly methods would be necessary. Therefore, prevention of discharge and dilution are necessary mitigation options when considering a possible management goal of no measurable water quality change from existing conditions.

Of the natural and scientific resource areas located in the Study Area, only two, the Boundary Waters Canoe Wilderness Area (BWCA) and the South Kawishiwi River Special Area (SKRSA), could be indirectly impacted by waste waters of copper-nickel development. Of these two areas, the BWCA is of greater concern in terms of water quality and wilderness preservation. The SKRSA is an environmental research center but is not oriented towards aquatic ecological research in the South Kawishiwi River. It also includes a campground and is used for recreational purposes (see Volume 5-Chapter 9 for more information about water quality impacts on recreational resources). Because of the difference in the historic use of these two areas, management goals would likely differ, especially concerning the "no change" policy.

Development in zones 1 and 2 could result in substantial changes in the water quality of the South Kawishiwi River in the vicinity of the SKRSA. The median background sulfate and nickel concentrations in this river (as measured at station K-7 between November, 1975, and April, 1977) were 6.3 mg/liter and 1.00

ug/liter, respectively (Table 4). Water discharge models developed by the Regional Copper-Nickel Study (Volume 3-Chapter 4, sections 4.4 and 4.6) indicate that sulfate concentrations two orders of magnitude (100 times) greater and nickel concentrations three orders of magnitude (1,000 times) greater than background concentrations are possible. Because of the proximity of potential development to the SKRSA, dilution may reduce these values by only 50 percent. This indicates that either reduction of discharge volume or extensive treatment would be necesary to maintain background stream concentrations. Elimination or significant reduction of discharge volume is possible during the active life of the mining operation, but not during the post-production phase of development (see Volume 3-Chapter 4, section 4.7 for more detailed information on water quality impacts).

Waters in the BWCA would be affected by copper-nickel development located north of the Laurentian Divide (zones 1-3 and part of zone 4). A portion of zone 1 is located within a small watershed which drains directly into the BWCA and development within this area would have the highest potential for impacting the BWCA (Figure 4). Water discharges from copper-nickel operations located in the moderate impact zone (Figure 4) would be diluted by receiving waters produced by a 1,347 sq mi (3,490 sq km) watershed before it reaches the BWCA. Assuming a 4.5 cfs waste water discharge containing from 2,420 to 4,700 ug/liter nickel and 550 mg/liter sulfate, the quality of the Kawishiwi River as it enters the BWCA near K-1 would be 11 to 21 ug/liter nickel and 9 mg/liter sulfate during annual average flow conditions and assuming conservation of chemical mass in the aqueous phase. This represents a 1,000 to 2,000 percent change in nickel concentrations and 29 percent change in sulfate concentrations over median background levels. The predicted nickel concentrations are clearly higher than the range of nickel

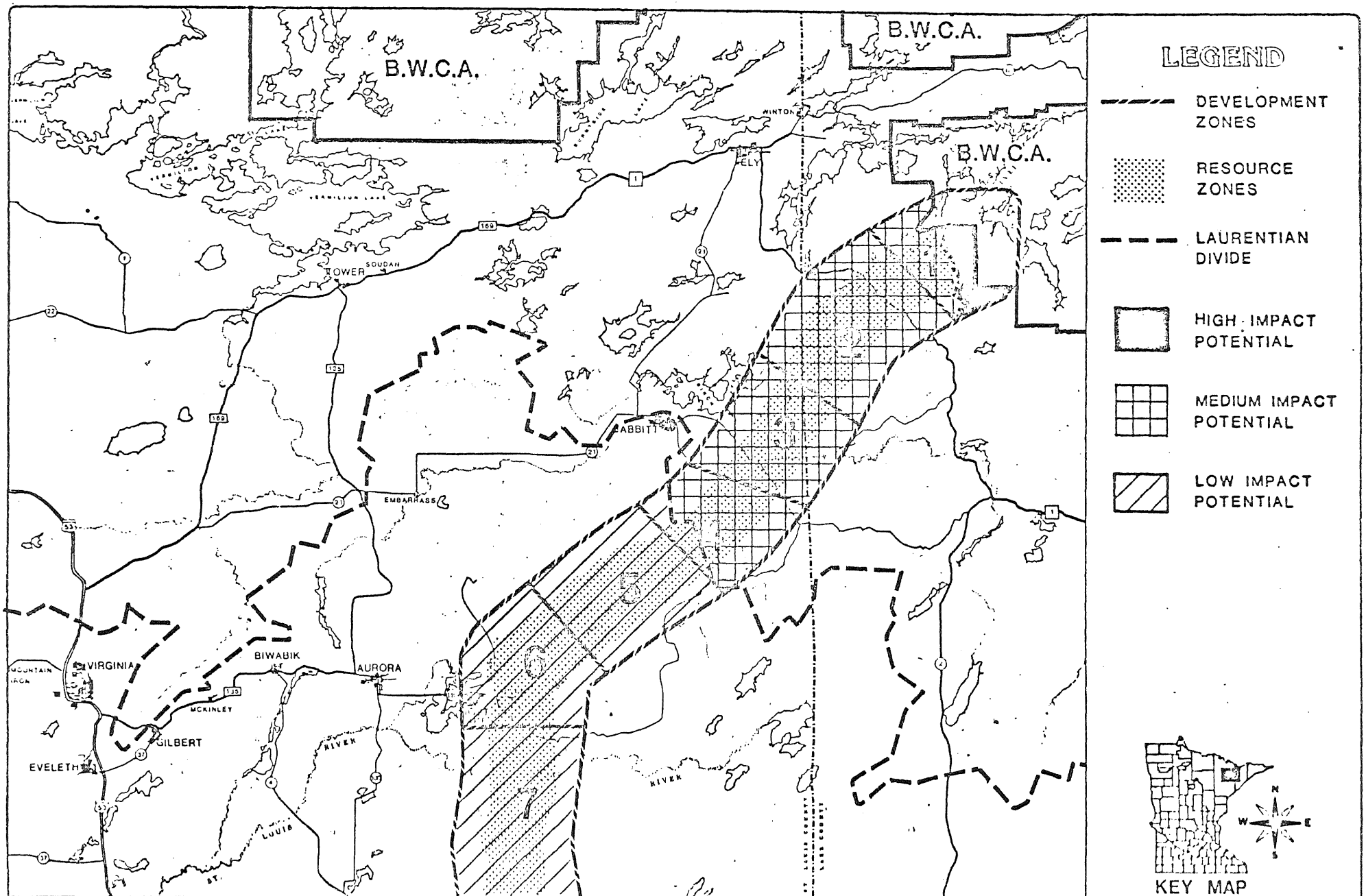


FIGURE 4. **MEQB REGIONAL COPPER-NICKEL STUDY**

B.W.C.A. WATER QUALITY IMPACT POTENTIAL OF DEVELOPMENT ZONES OUTSIDE THE B.W.C.A.

values recently measured at K-1 (Table 4), but the predicted sulfate concentration is within the range measured at this same location.

If a criteria of two standard deviations above the mean concentration of background measurements is used to determine measurable change from existing conditions, then a concentration of 3.38 ug/liter nickel and 11.17 mg/liter sulfate should not exceeded at the Kawishiwi River where it enters the BWCA (station K-1). Using the conservative mass balance model (Volume 3-Chapter 4, section 4.7), a 4.5 cfs discharge having a nickel concentration not exceeding 560 ug/liter and a sulfate concentration not exceeding 990 mg/liter would meet this criteria, if copper-nickel development was located in the moderate impact zone. If more than one copper-nickel operation occurred in this area, then the above maximum concentration would have to be reduced accordingly in order to meet the management goal. The present MPCA ambient water quality standard for sulfates is 250 mg/liter (domestic consumption) and the proposed MPCA standard for nickel is 6.5 ug/liter (assuming a mean total hardness value of 28 mg/liter). If the above standards are met, the assumed criteria of no measurable change of the BWCA water quality would be assured. Unfortunately, it is unlikely that the proposed nickel standard could be met during the post-production phase of copper-nickel development. Conventional waste water treatment systems using pH adjustment methods can reduce nickel concentrations below 500 ug/liter, but the effectiveness of passive reclamation methods in controlling nickel levels is unknown at this time.

10.4.3 Air Quality Changes

Air quality changes resulting from copper-nickel mining and smelting are not expected to significantly impact most natural and scientific resource areas in

Table 4. Surface water quality at selected stations in the Regional Copper-Nickel Study Area.[a]

	So. Kawishiwi River at K-7			Kawishiwi River at K-1			Isabella River at I-1		
	min	max	medium	min	max	medium	min	max	medium
SO_4 (mg/liter)	3.0	10.0	6.3	4.3	11.0	7.0	1.0	9.6	5.5
Ni (ug/liter)	0.4	3.0	1.0	0.6	4.0	1.0	0.4	2.0	1.0

[a]For time period November, 1975, to April, 1977.

the Study Area if the developments are designed and operated so that they conform with present state and federal air quality regulations. The exceptions to the above finding are the Keeley Creek Research Natural Area (RNA) and the South Kawishiwi River Special Area because they are located in the development zone and are not covered by the Class I PSD (Prevent Significant Deterioration) requirements of the USEPA. The BWCA is presently protected by these stringent regulations.

Air pollutants from copper-nickel development could indirectly impact on natural and scientific areas by four principle causes: 1) fugitive dust from open pit mines, haulroads, and tailing basins; 2) very high concentration sulfur dioxide emissions from a smelter caused by breakdowns of pollution control equipment; 3) aggravation of existing and projected acid precipitation conditions in northeastern Minnesota; and 4) deposition of heavy metals resulting from a smelter operation.

Fugitive dust emissions will only cause significant changes in existing air quality near the source of such emissions. The large open pit mine model producing 20.0 million mt of crude ore per year emits the largest quantity of dust of the models developed, especially if trucks are used to haul ore and waste rock. Based on the analysis presented in Volume 3-Chapter 3, section 3.8.1.2, it will be difficult for an open pit operation located within some 10-15 km of a Class I area to meet the 24-hour PSD requirements. Extremely effective dust control measures would be necessary, particularly on haul roads. Fugitive dust from a large mine-mill development may also exceed the Class II 24-hour PSD increments within close proximity of the mine and mill areas (i.e. within 1 km or less).

Fugitive dust presents less of a problem in the case of an underground operation, although Class I standards may still be exceeded within a few kilometers of the operation. Reasonable dust control measures should allow the Class I increment to be met beyond the immediate (1/2 to 1 km) vicinity of the operation.

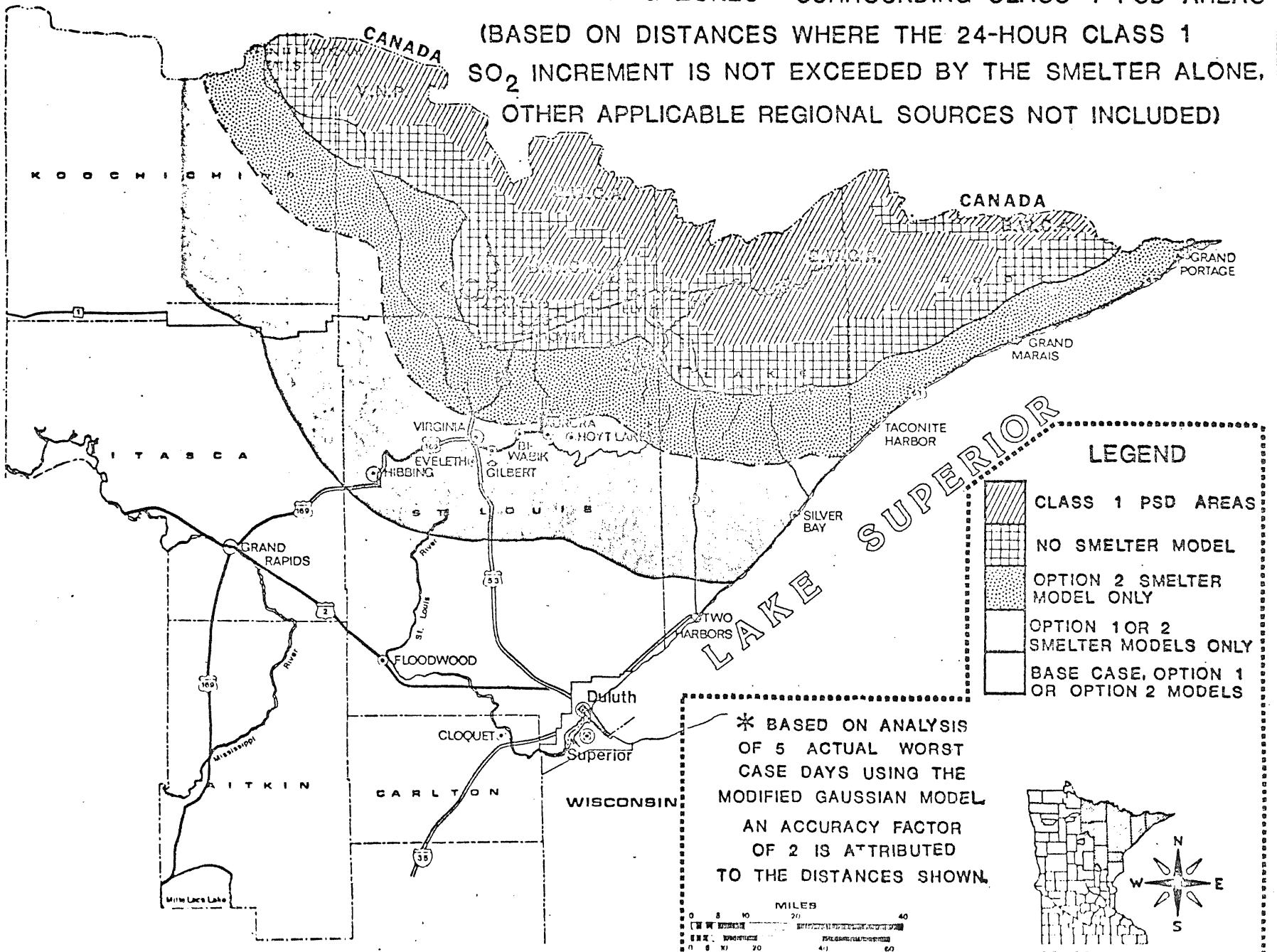
The BWCA, Keeley Creek RNA, and the SKRSA would be most susceptible to air quality impacts caused by fugitive dust emissions because of their proximity to or location within the copper-nickel development area. The BWCA is presently protected by federal law from significant air quality changes unless facilities are exempted from these requirements (provisions for exemptions are provided for within this law and corresponding EPA regulations). The other areas mentioned above are protected under the same law but not to the same degree. The Keeley Creek RNA is used for long-term research studies of forest succession (among other research uses) and for preservation of the area in a natural state. Significant anthropogenic changes in dust loading on this area could reduce its usefulness as a research resource and natural area. Impacts could be greatly reduced if state-of-the-art control methods are utilized and if dust sources are not sited directly adjacent to this area. Since open pit mining is not likely in zone 2 (based on available drill core information), mitigation of indirect impacts caused by fugitive dust on the Keeley Creek RNA should be possible.

Emissions of sulfur dioxide from a smelter using state-of-the-art emission control systems and sited far enough from Class I PSD areas (Figure 5) should not cause significant changes in the air quality of natural and scientific resource areas under normal operating conditions. Under breakdown conditions, very high stack releases of sulfur dioxide could occur causing major changes in air quality. This could result in visual damage to vegetation over a distance of +10 km downwind of the smelter. In order to protect natural and scientific areas

FIGURE 5

SMELTER SITING ZONES* SURROUNDING CLASS 1 PSD AREAS

(BASED ON DISTANCES WHERE THE 24-HOUR CLASS 1 SO_2 INCREMENT IS NOT EXCEEDED BY THE SMELTER ALONE, OTHER APPLICABLE REGIONAL SOURCES NOT INCLUDED)



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from risks of damage during these upset periods (frequency unknown), a smelter should not be sited within 10 to 20 km of such areas. Since the probability of risk depends on the frequency of wind directions, risk of damage can be greatly reduced by not siting a smelter in a northwesterly, or south, southeasterly direction of natural and scientific areas. For more information on the implications of smelter upset conditions see Volume 3-Chapter 3, section 3.7.1.3 and Volume 4-Chapter 2, section 2.1.9.2.

Northeastern Minnesota is presently being impacted by acid rain. One source of this problem is the long distance transport of sulfur dioxide and its oxidation products (e.g. sulfates). Analysis by the Regional Copper-Nickel Study (Volume 3-Chapter 3, section 3.7.3) indicates that a copper-nickel smelter will not be a major contributor to the acid rain problem. However, any new large sulfur dioxide source in the region can only aggravate a potentially very serious ecological problem.

The deposition of heavy metals and resultant increased loading of soils probably represents the most severe terrestrial impact of air pollution that can be expected from a smelter in northeastern Minnesota. Heavy metal loadings decreases the rate of litter decomposition and may produce deep litter layers which are poor seedbeds for species such as red and jack pine that require mineral soil for establishment. In addition, reduction in litter decomposition rates reduces nutrient recycling in forest ecosystems (Volume 4-Chapter 2, section 2.9.1.1). As previously mentioned, significant changes in natural processes within scientific and natural areas greatly reduce, if not eliminate, the value of such areas for their designated use. Avoiding the use of a spray drier for concentrate drying in the smelter and/or using state-of-the-art particulate control systems could reduce the areal extent of slowed decomposition to within a distance of 2 km of the smelter.

In summary, indirect impacts on natural and scientific resource areas due to air pollutant emissions from copper-nickel development could occur, but could essentially be eliminated by use of adequate pollution control systems and/or careful siting of facilities. Since the mine-processing plant facilities must be located in or near the development area, the potential for impacts on scientific and natural areas is greatest in zones 1 and 2. A smelter does not have to be located in the development area or the Study Area; therefore, siting becomes a major mitigating factor.

10.4.4 Residential Settlement Growth

Copper-nickel mining development would attract new residents to the Study Area. Forecasts developed by the Regional Copper-Nickel Study predict roughly a 55% increase of residents over 1976 levels with the development of 3 copper-nickel mining operations along the contact (see Volume 5-Chapter 7, Residential Settlement, for a more complete discussion of these forecasts). This growth in population of approximately 27,750 new residents could result in increased use of some of the areas that are presently open for recreation. Not enough is known about recreational use in the Study Area to determine where or if this increased user pressure would cause changes in the natural and scientific resources areas. The areas that would be most subject to this pressure would be designated areas open to recreation and proposed areas with no governmental status to regulate use.

Population growth generated by copper-nickel development would also result in an increase in the amount of land used for residential settlement. The rural areas that would receive the largest increase in residential settlement would be in and around Ely, the Embarrass Valley region, and the southwest section of the Study

Area (Figure 6). Most of the natural, scientific, and historic areas are not located in the same area as predicted residential settlement growth. Also, areas that are publicly owned would not be developed for residential purposes. The Bass-Dry Lakes Area (a proposed National Natural Landmark and proposed State Scientific and Natural Area) and Burntside Islands (a Nature Conservancy Preserve) are located within the residential settlement area. One state historic site and one state archeological site are also located in this region but would be protected from development by state law.

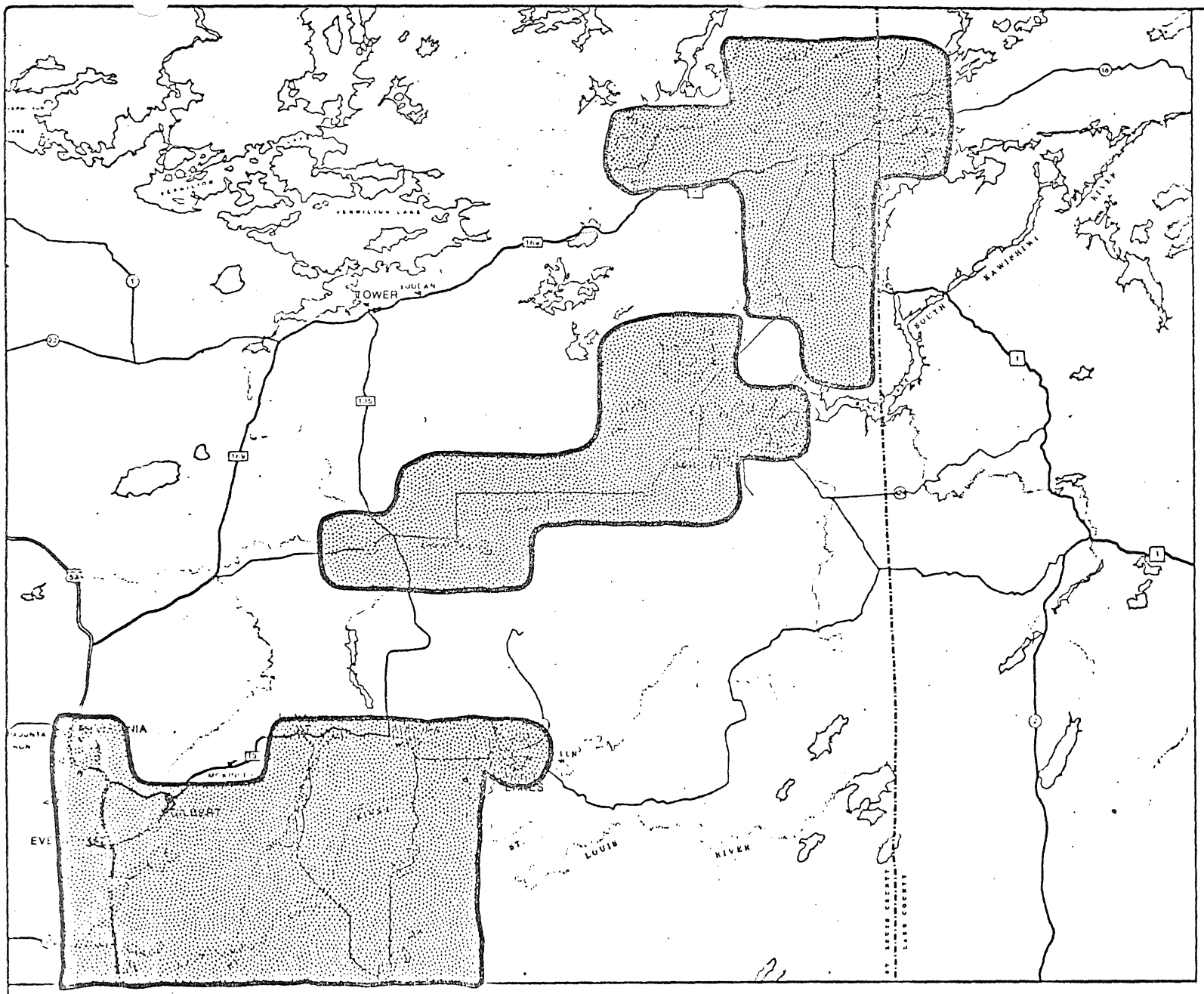

FIGURE 6

MEQB REGIONAL COPPER-NICKEL STUDY

AREAS ACCOUNTING FOR 90 % OF NEW SETTLEMENT
RESULTING FROM THREE COPPER-NICKEL DEVELOPMENTS

10.5 REFERENCES

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