Volume 5-Chapter 3

LAND USE-LAND COVER OVERVIEW

Minnesota Environmental Quality Board
Regional Copper-Nickel Study

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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 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		

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Volume 5-Chapter 3 LAND USE-LAND COVER OVERVIEW

3.1 INTRODUCTION TO LAND USE-LAND COVER OVERVIEW

The following 7 chapters (4-10) of this volume characterize and discuss land use impacts relevant to copper-nickel development in the Regional Copper-Nickel Study Area (Study Area). This chapter serves as an introduction and summary of these chapters and integrates this with information into an overview of Study Area land use issues. There are 3 main sections in this chapter.

1) The first section characterizes existing patterns of land use-land cover in the Study Area and compares them with the patterns for northeastern Minnesota (Region 3) and for the state as a whole. In addition, the present management of Study Area land resources is discussed.

2) The second section describes the two principal types of impacts that will affect Study Area land use-land cover patterns: the direct consumption of land by new mining and related uses; and the secondary impacts which will result from the growth in the Study Area population--primarily the consumption of land by increased residential settlement and an expanded service sector of the economy.

3) The third section presents hypothetical land cover patterns for the Study Area in the year 2000 and analyzes the importance of the changes by assessing the extent of the resultant impacts to various land use types.

3.1.1 Land Use-Land Cover Defined

The distinction between land use and land cover is not always clear. Generally speaking, a land cover map illustrates the patterns of natural and man-made physical features over the surface of an area, while a land use map more specifically defines the uses of a particular parcel of land. For example, a given parcel of land could be covered with forests but could conceivably be used for a range of activities such as timber production, recreation, or wildlife management.

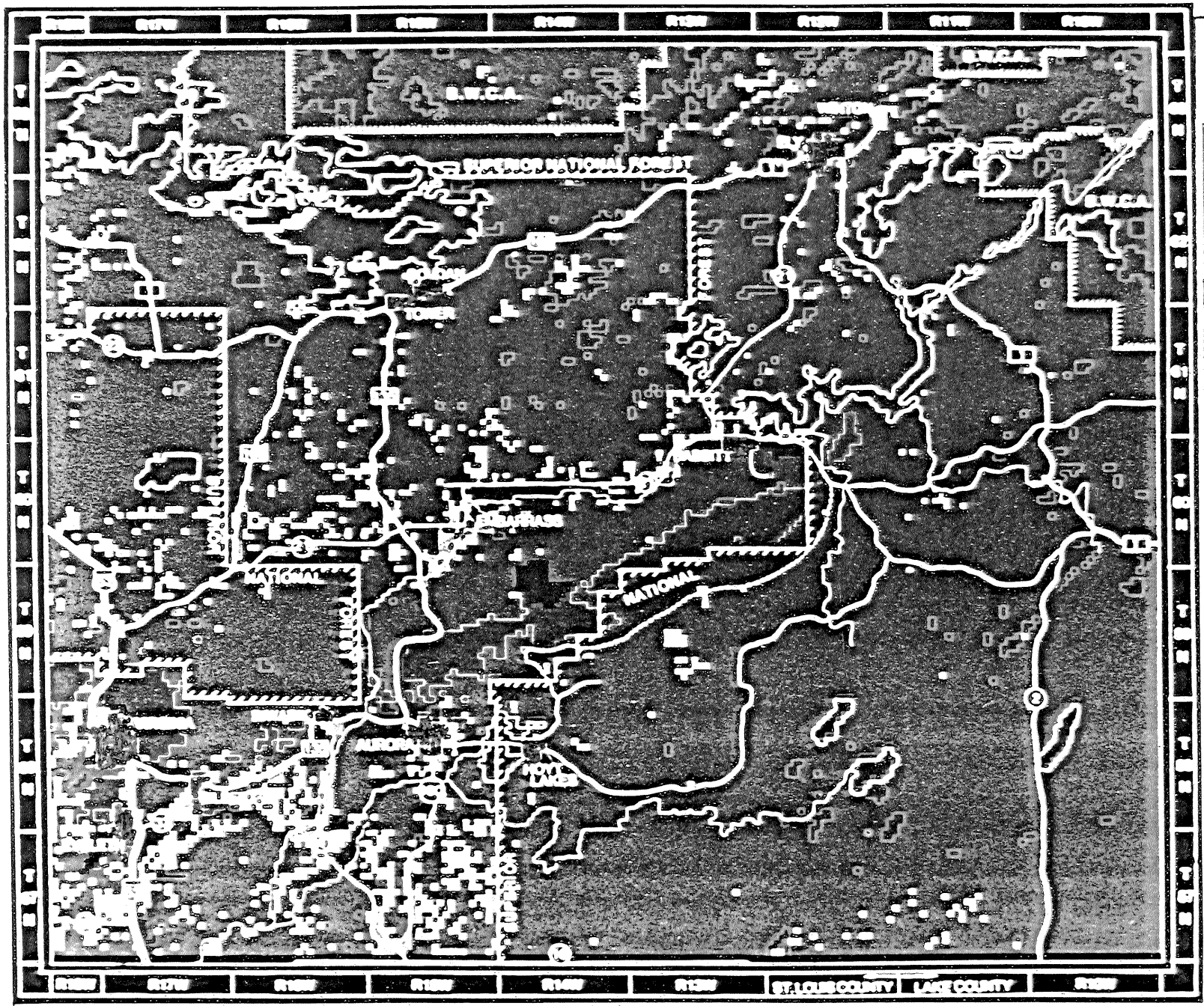
Certain land cover categories, however, such as mineland or transportation describe both the general types of man-made features that cover the land and the way the land is used.

The term "land use" is commonly used on maps and in the literature when referring to both land use and land cover. This report, however, will distinguish between land use and land cover when appropriate and will refer to "land use-land cover" when discussing patterns and impacts involving both.

3.1.1.1 Land Cover--The 8 general categories of land cover used in this overview are:

1) Mineland
2) Water
3) Residential/commercial/manufacturing and urban areas
4) Cultivated and other agricultural land
5) Rough pasture and other non-forested open/vacant land
6) Forestland
7) Permanently wet, non-forested swamps and bogs
8) Transportation corridors and facilities

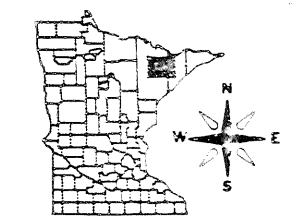
The distribution of these land cover categories over the Study Area is presented in Figure 1, which was compiled in 1977 by Copper-Nickel Study staff by interpreting aerial photographs of the region and conducting a ground survey in the field. Land cover figures for the state as a whole and for the 7 counties of Region 3 were drawn from the Minnesota Land Management Information System (MLMIS) Variable 16, showing land use by county in 1969 respectively. Although these sources contain categories which are a combination of land use and land cover, the condensation of several levels of information created roughly parallel land cover classifications at all 3 levels.



LEGEND

- MINELAND - PITS, DUMPS PLANTS & RELATED USES
- TAILINGS BASINS
- WATER
- URBAN
- RURAL RESIDENTIAL
- MANUF./TRANS/UTILITIES /IND./COMMERCIAL
- OPEN-VACANT/ AGRICULTURE
- FOREST/SWAMPS

SOURCE: REGIONAL COPPER-NICKEL STUDY (MLMIS VARIABLE V45-FILE 0)



KEY MAP

1:422,400

MILES 0 1 2 3 4 5 10

0 1 2 3 4 5 10 15 KILOMETERS

MEQB REGIONAL COPPER-NICKEL STUDY

FIGURE 1

LAND USE

3.1.1.2 Land Use--In discussing the Study Area, this chapter considers the 12 general types of land use listed below with representative examples of the activities included in each land use category. The land in the Study Area is used to:

1) Mine--i.e. to extract ore, stockpile lean ore, dump waste rock, dispose of tailings, process the raw ore, transport the processed ore, store equipment, house management functions, visually buffer the operation, etc.

2) Manufacture various goods and industrially process other raw materials.

3) Commercially sell and distribute goods and services.

4) Accommodate urban activities, services, and structures not already listed--such as high density housing, medium density housing either served by municipal services or contiguous with other urban uses, city streets, public buildings, parks, hospitals, churches, etc.

5) Provide rural residenses--i.e. to house the population, provide yard space around the residence, and accommodate non-commercial outbuildings.

6) Transport people, goods, and raw materials on paved highways, unpaved roads, rail lines, water routes. Further, to provide for airplane takeoffs and landings, as well as the loading, unloading, and transfer of people and cargo.

7) Produce agricultural products--i.e. to grow crops, cut hay, raise livestock, run dairy herds, and maintain orchards.

8) Provide recreational activities--i.e. to hunt, fish, snowmobile, canoe, camp, boat, ski cross-country and downhill, hike, drive for pleasure, gather wild food, picnic, swim, golf, and provide lodging in a recreational setting.

9) Manage wildlife by establishment of game preserves, protected habitats, natural and scientific areas, and hatcheries.

10) Preserve sensitive ecosystems and wilderness such as the BWCA.

11) Raise and commercially harvest timber and manage land for future timber production.

12) Manage resources not already listed such as peat and undeveloped mineral deposits.

There are portions of the Study Area which for various reasons including inaccessability, unsuitability, and neglect are not actively managed for a specific use. The extent of these lands is unknown but it can be assumed that a great

deal of the swampy and non-forested open/vacant land as well as some remote forest land falls into this category.

3.1.1.3 Correlation of Land Cover and Land Use--Figure 2 shows the correlation of land uses to land cover categories by depicting for each land use the land cover type(s) where it may be found. The number of uses occuring in a given land cover type ranges from the two uses found in the mineland cover type to the seven uses which can be found in areas covered by forest. The residential/ commercial land cover category accommodates six of the general land use types but it must be noted that the six use types are those uses describing generally urban areas. This is an instance where several land use classifications were condensed to create an overall land cover category.

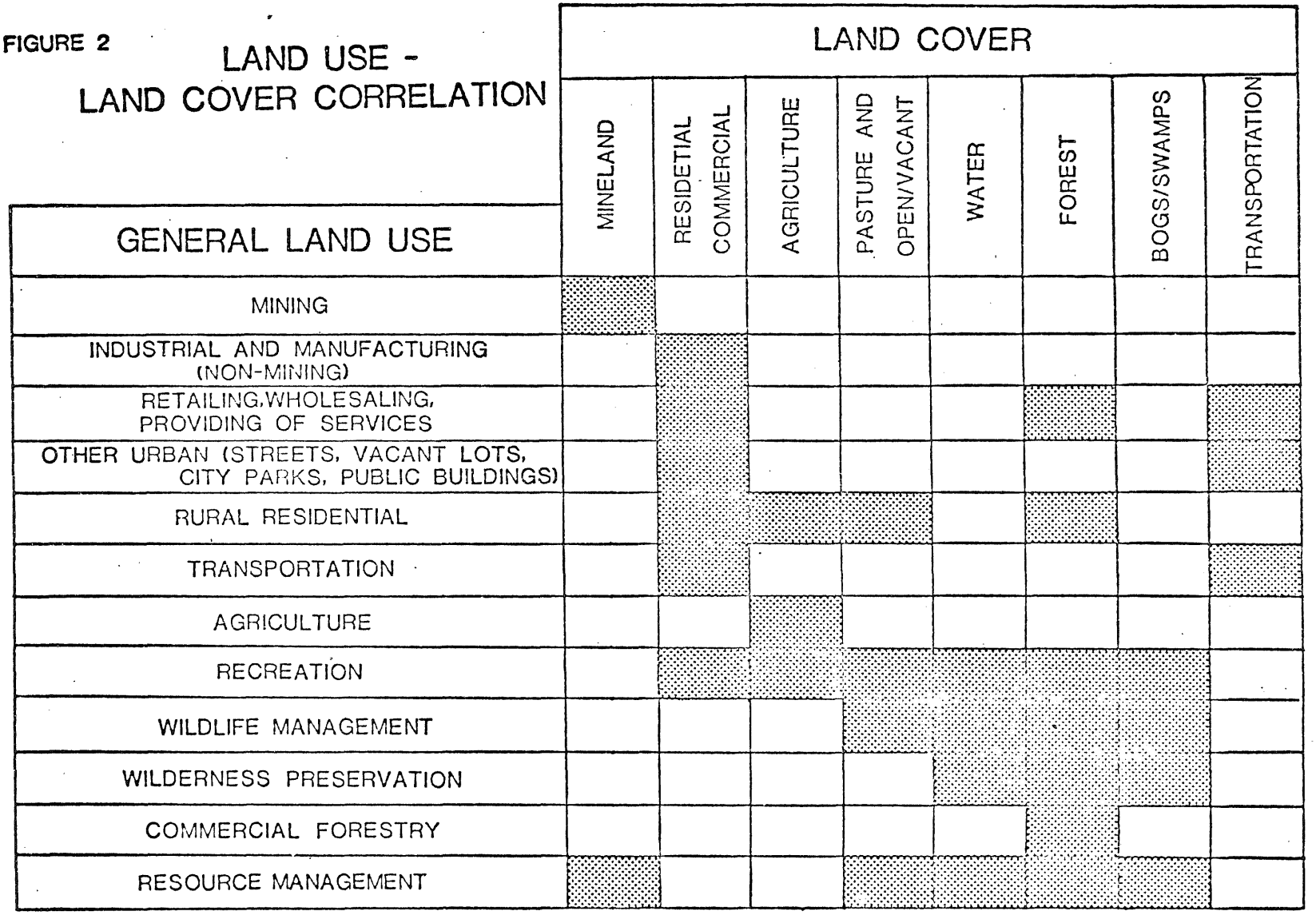
The land use found in the largest number of land cover categories is recreation which can occur in six of eight land cover classifications. The land uses which occur in a single land cover category are mining, other industrial, agriculture, and commercial forestry. The reader should keep in mind that any correlation between land use and land cover is often a result of how the classifications are defined.

3.1.2 Reasons for a Regional Land Use-Land Cover Impact Analysis

Land is a finite resource and can accommodate only a limited number of uses. This means that there is often competition for a parcel of land between interests that would occupy or use the land for different activities. Multiple use policies attempt to minimize the conflicts between users while at the same time maximizing the benefits received from the land. This approach is limited by the fact that certain land uses (mining for instance) effectively exclude other uses and others (commercial forestry for instance) may be more productive if the

FIGURE 2

LAND USE - LAND COVER CORRELATION



accompanying uses are carefully selected and managed. Land management officials at the local, state, and federal levels will be faced with the need to address important land use issues that will result from copper-nickel mine development in the Study Area. Increases in the amount of land consumed by mining itself and the associated growth in the amount of land required to house and service a larger population will step-up the competition for the remaining land.

3.2 EXISTING STUDY AREA LAND USE-LAND COVER PATTERNS

The land use-land cover patterns of a region reflect not only that region's local economic structures, history, and geography, but also reflect government management decisions made at state and federal levels calculated to help meet future state and national needs for such resources as timber, recreation, and minerals. All of these influences are visible in the land use-land cover patterns of the Study Area.

3.2.1 Dominant Land Cover Features and Major Land Uses-Study Area, Region 3, State

The total land area of the Study Area is approximately 2,100 square miles or 1,364,160 acres (552,292 ha). It is roughly 1/40th of the area of the State of Minnesota and 1/10th of the area of the seven counties of Region 3 (Cook, Lake, St. Louis, Koochiching, Itasca, Aitkin, and Carlton)(See Figure 3).

3.2.1.1 Forest--The Study Area is located within Region 3 in the northeastern part of the state which is dominated by forest cover (Figure 3). Forested areas account for fully 77% of the land in the Study Area and 82% of the land in Region 3 (recall, however, that this is exclusively a description of land cover and does not bear directly on the uses of this land)(Figures 1 and 3). By comparison, only 34% of the state is covered with forests (Table 1).

FIGURE 3

REGION 3 - LAND USE

MEQB REGIONAL COPPER-NICKEL STUDY

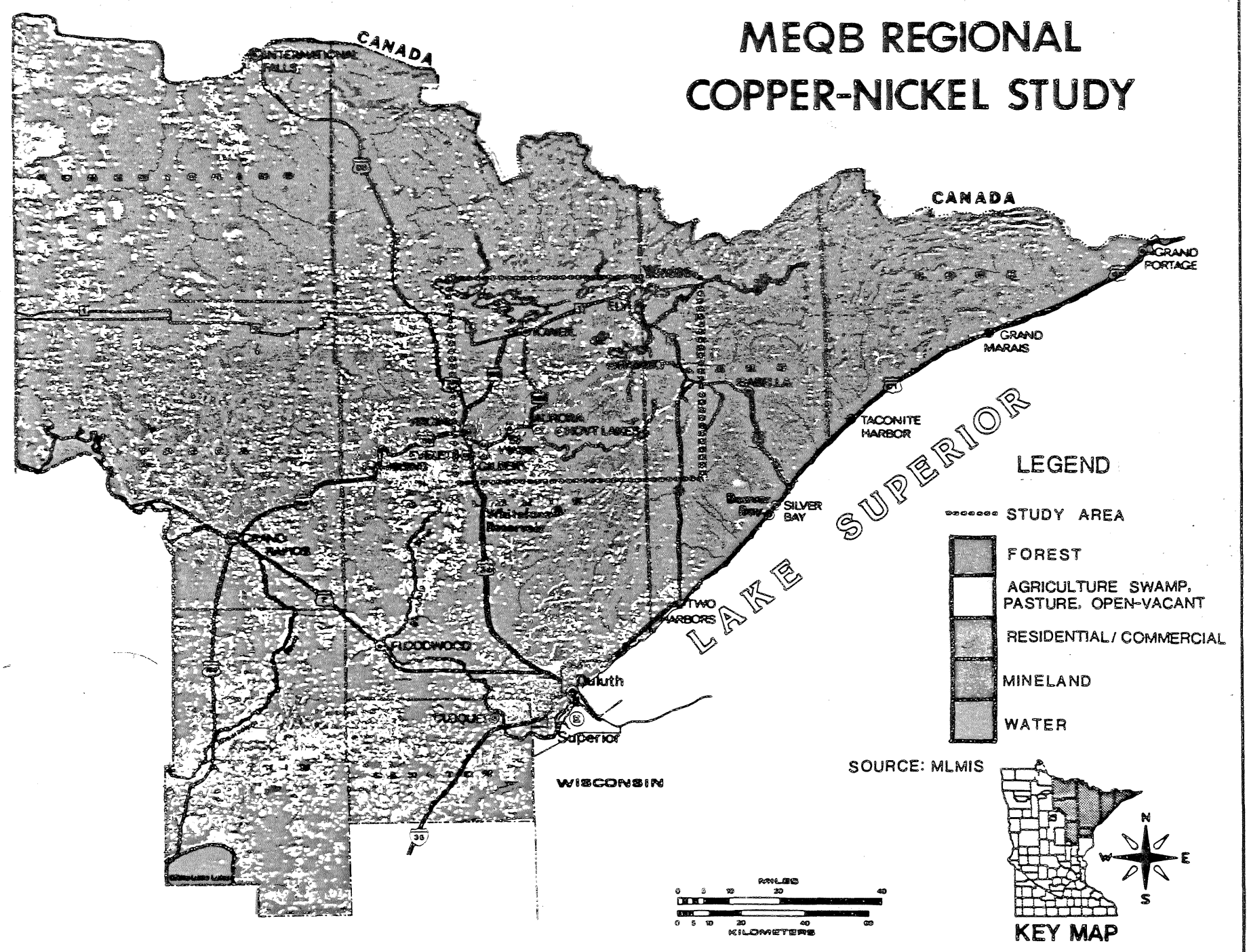


Table 1. Land cover in the Study Area, Region 3, and state.

LAND COVER TYPE	STUDY AREA[b] Approx. Acreage	STUDY AREA[b] % Total Study Area	REGION 3[c] Approx. Acreage	REGION 3[c] % Total Study Area	STATE[c] Approx. Acreage	STATE[c] % Total Study Area
Minelands[a]	44,360	3	64,920	1	87,640	*
Water	109,480	8	825,880	6	2,906,760	5
Residential/ Commercial	29,400	2	194,160	2	1,191,760	2
Transportation	1,520	*	5,720	*	26,120	*
Cultivated/ Agricultural	27,320	2	236,200	2	23,750,280	44
Pasture/Open	47,880	4	606,560	5	6,015,880	11
Forest	1,049,360	77	10,377,360	82	18,440,640	34
Bogs/Swamps	54,840	4	375,840	3	1,868,080	3
TOTAL	1,364,160		12,686,640		54,287,160	

SOURCES: [b]Regional Copper-Nickel Study Land Use '77 Map, MLMIS V-45 file 0.
[c]MLMIS V-16, Land Use '69.

*Less than 1%.
[a]Not including reservoirs.

Almost all of the forested lands in the Study Area are made up of aspen-birch stands (57% of all forested lands), spruce-fir (30%), or white, red, and jack pine (10%) stands. These three cover types account for almost all of the timber harvested in the region and the quantity of each harvested is roughly proportional to the area covered by each. The forest products industry is the third largest industry in northeastern Minnesota accounting for approximately 8.4% of the total gross output of Region 3 in 1970 (compared to 19% for the iron ore industry)(SIMLAB 1978).

Over half of the forest lands in the Study Area are publicly owned and managed by either the United States Forest Service (USFS), Minnesota Department of Natural Resources (MDNR), or the county land management offices. Currently, forest lands are managed for several uses in addition to forestry. These include recreation of various types (hunting, fishing, snowmobiling, hiking, and canoeing among others), wildlife management, watershed protection, wilderness preservation, and ecological research.

3.2.1.2 Water--The numerous lakes and streams in the region make up 8.0% of the Study Area. This is a larger percentage of the total area covered in water than for either Region 3 (6%) or the state (5%). Most of the accessible lakes in the Study Area are commonly used for recreational activities such as fishing, boating, canoeing, and wild rice harvesting.

Although actual water coverage is only 8% of the total Study Area acreage, the amount of land in the Study Area that is within one half mile of a lake or one quarter mile of a stream (slightly more than 37% of total Study Area acreage) more accurately expresses the significance of water as a land cover feature in the Study Area. The number of water oriented recreational facilities in the

Study Area further attests to the importance of this resource. In the Study Area there are; 58 public boat accesses and 20 public swimming beaches (undoubtedly there are many similar private facilities), and 102 resorts.

3.2.1.3 Minelands--Land used for mining is a very prominent feature of the Study Area (Figure 1). Approximately 44,360 acres (17,960 ha) or 3% of the Study Area falls into this category. The relative significance of this figure lies in the fact that Study Area minelands account for just over 51% of all the minelands in the state while the Study Area itself represents only 3% of the area of the state. This same relationship holds true for the Study Area when compared to all of Region 3 (Table 1).

Taconite mining and processing operations located along the Biwabik Iron Formation are the principal industry in the Study Area and have been, along with the timber and tourism industries, one of the three major private sector forces shaping the Study Area land use-land cover pattern. The locations of all major residential settlements in the Study Area have been determined by the presence of iron ore or taconite mines. The transportation network in the area has likewise grown directly out of the need to service the mining operations and resultant population centers.

An important aspect of minelands supporting active mining operations as a land cover feature is their inability to serve multiple uses with the possible exception of the large reservoirs maintained by the mining operations which are used for recreational and water supply purposes. Reclamation of minelands after mining ceases will hopefully lead to their eventual productive use for recreation or forestry, for example.

3.2.1.4 Residential/Commercial--The residential and commerical land uses in the Study Area cover 2% of the total area and include urban areas, rural residential settlements, commercial properties, industrial and manufacturing lands other than minelands, and utilities and communication facilities. The proportion of land devoted to these land uses in the Study Area is the same as that for the state as a whole.

Seventy percent of Study Area residences are found in the nine cities in the Study Area. Seven of the nine cities are located immediately adjacent to the Biwabik Iron formation which is presently the scene of the large scale taconite operations. The heaviest concentration of residential settlement occurs in the southwest section of the Study Area between Virginia and Hoyt lakes where 64% of the residences are located. Another 24% are located in the cities of Babbitt and Ely and the surrounding resort area. The major rural settlement other than those along popular lakes is the settlement found in the Embarrass River Valley roughly paralleling County State Aid Hwy. 21.

The number of residences in the Study Area increased by roughly 10% between 1970 and 1976 from 15,290 to 16,720 with more than half (56%) of the new homes being built in the southwest portion of the Study Area between Virginia and Hoyt Lakes. Another one quarter of the overall increase in the number of residences is accounted for by growth in the Embarrass River Valley. Growth in both the amount of land used for urban, commercial, and residential purposes and in the amount used for primarily rural residential settlements has, in the past eight years, brought the area devoted to this land cover type to 29,400 acres (11,903 ha) or 2% of the total area of the Study Area.

3.2.1.5 Agriculture--In the State of Minnesota, 44% of the land is devoted to agricultural uses. In the seven counties of northeastern Minnesota, including

the Study Area, only 2% of the land is cultivated. This reflects differences in the soil quality, the length of the growing season, the vegetation cover, and the socio-economic factors (e.g. availability of jobs) in the northeastern counties compared to the remainder of the state.

The 27,320 acres (11,060 ha) of agricultural land in the Study Area is found primarily in three distinct sections of the Study Area; the Embarrass River valley, the open land south of Aurora and Biwabik in the southwest, and in a small pocket of old farmsteads centered around the town of Toimi in the southeastern corner of the Study Area. The generally thin and rocky quality of the soil in the region limits the types and quantity of cash crops which can be successfully grown in the area; therefore, much land in agricultural areas is used primarily to graze livestock. A large number of farmsteads have been abandoned over the years with the result that there is more land that had once been cleared and is now idle or vacant than there is cultivated agricultural land.

3.2.1.6 Pasture and Open/Vacant Land--Land in this classification includes all non-forested land (excluding replanted clearcut land, cultivated land, bogs and swamps, and water) which is not otherwise developed (e.g. as residential or industrial land). This land includes rough pastures not included with higher quality agricultural land noted above and vacated farmsteads which are not obviously used for another purpose. The 47,880 acres (19,385 ha), or 4% of the total Study Area, of open/vacant lands in the Study Area are generally located in the same areas as the agricultural land. There is, like agricultural land, proportionally less pasture and open/vacant land in the Study Area then in either Region 3, where this classification accounts for 5% of the total area, or the state (11%).

3.2.1.7 Transportation--Despite the extent of the transportation facilities associated with the taconite mining industry in the Study Area, transportation land uses account for only 0.1% of the total area of the Study Area. (Note: the MLMIS maps from which land cover information was taken are compiled on the basis of dominant land cover by 40 acre parcel. For this reason, transportation and utility corridors such as roads, railways, and transmission line right-of-ways are likely to be under-represented with the result that overall transportation land cover is somewhat understated in this chapter.) MLMIS supplied data showing transportation land cover to be less than 1% for both Region 3 and the state as well.

The relative scarcity of roads in the Study Area can be seen in the fact that only about 22% of the land in the Study Area is directly accessible from or within one quarter of a mile of either a paved or unpaved public road. There are large portions of the Study Area, principally in the forests and swamps of the southeast and the forests of the far north, that are roadless and virtually inaccessible. There are in many cases old logging roads which do penetrate these areas but they are frequently impassable.

3.2.1.8 Bogs and Swamps--Four percent (54,840 acres, 22,202 ha) of the Study Area is covered with permanently wet, non-forested bogs and swamps. While bogs and swamps are found throughout the Study Area, the largest continuous swamplands are located just north of the Seven Beaver Lakes area in the eastern part of the Study Area, immediately south of the eastern end of Biwabik Iron Formation, and in the Lost Lake region south of Lake Vermilion.

3.2.2 Land Use Management in the Study Area

In general, the way or ways in which a parcel of land is used are determined by the individual or organization which owns or controls the land. However, the realization that land itself is a limited resource has prompted many government agencies to adopt a system of land management which usually allows for public discussion of the varying opinions on many land use policy issues and in some cases, such as certain zoning and environmental protection laws, directly regulates land uses in a particular jurisdiction.

3.2.2.1 Major Study Area Land Use Policy Makers--Initially, major land use policy makers can be broken down into public and private sectors. Public land use policy makers in the Study Area are: 1) the Bureau of Land Management (BLM) and the United States Forest Service (USFS) at the federal level; 2) the Minnesota Department of Natural Resources (MDNR) at the state level; 3) the St. Louis and Lake County land management offices which determine policy for lands directly controlled by the counties; 4) the St. Louis and Lake County boards which determine the zoning regulations for non-incorporated portions of the Study Area and for incorporated areas which have not established their own zoning regulations; and 5) the municipal governments which establish zoning regulations for land within their municipal boundaries. Major private holdings of land in the Study Area are owned or controlled by the mining, timber, and railroad industries; real estate speculators; and the numerous individuals who own land for residential or commercial purposes.

Approximately 52% of all surface lands in the Study Area are under federal, state, and county ownership. Federal land ownership (30% of all Study Area lands) is concentrated in the Superior National Forest (SNF) under the control of the SNF Supervisor's Office in Duluth. Overall land use policy for the National Forest system is established by the USFS, U.S. Department of Agriculture. The

existing management plans for the SNF are over ten years old and generally reflect a philosophy of multiple land uses (timber management, recreation, wildlife management) coupled with the traditional silvicultural practice of managing extensive acreages at low productivity levels. New management plans for the SNF currently being prepared are expected to emphasize intensive management of the most commercially suitable forest land for high productivity while maintaining the position in support of multiple use.

State owned and administered lands (12% of all Study Area land) are fairly uniformly scattered throughout the Study Area and include state parks, state forest lands, swamplands, school, university trust fund lands, and miscellaneous dispersed parcels. State owned lands outside the state forests are administered by the MDNR Land Bureau. The MDNR Forestry Division is, like its federal counterpart, currently updating old management policies and is also expected to emphasize intensive management of land most suitable for commercial forestry.

County managed lands (approximately 10% of all Study Area land) are primarily tax-forfeited lands where the state has delegated administrative control to the counties. In the Study Area, county managed lands include 39,480 acres (15,983 ha) of land in the County Memorial Forests. There are no firm management policies presently established for these forest lands, although indications are that such policies may be implemented in the near future.

Decisions regarding land use which are made by private holders of land are generally guided by economic factors. The land and its resources directly generate income in the taconite, timber, and tourist industries. However, all these industries are regulated to a certain extent by the government. For example, a mining company wishing to dispose of tailings in an area not pre-

viously used for mining purposes must satisfy the requirements of the state and federal environmental protection laws. These government requirements typically provide an opportunity for those who do not approve of the change in land uses to make their views publically known.

To small private landowners, the most familiar form of land use regulation is the system of zoning districts which typically divide the land into zones where certain uses are either discouraged or simply not allowed. Eight of the Study Area cities and both St. Louis and Lake counties have zoning ordinances variously specifying minimum lot size requirements, the number of residential units per structure in districts which allow residences, districts reserved for heavy or light industry, and others. It must be noted that zoning ordinances as a land use regulating tool are frequently weakened by the ease with which variances to the ordinance and conditional use permits are granted.

3.2.2.2 Management Policy and Land Use Conflicts--Northeastern Minnesota, including the Study Area, is the scene of several examples of land use conflicts. One of the best known is the debate over use of the land designated as the Boundary Waters Canoe Area (BWCA). This conflict can be characterized as a dispute between those elements arguing on behalf of a multiple use management plan that would allow uses such as logging and motorized travel inside the BWCA and those elements arguing for a more restrictive management plan that would prohibit logging and motorized travel. While the controversy over the use of the BWCA was aggravated by the special environmental, aesthetic, and jurisdictional aspects of the land involved, the issues raised on both sides (such as the concerns of the timber industry over the scarcity of softwoods, the environmentalists concern over the incompatibility of logging with wilderness land uses, and the concern of area

resort operators that land management policies proposed by the environmentalists would adversely affect their use of the land as an income generator) are typical of the smaller conflicts within the Study Area that will need to be addressed in land management plans.

3.3 MAJOR LAND USE-LAND COVER IMPACT GENERATORS

In the event of any copper-nickel mine development in the Study Area, land use-land cover patterns will change to some degree depending on the size, siting, type, and number of mining operations undertaken. Presented below is a general discussion of the two categories of impacts expected to most greatly influence land use-land cover in the Study Area.

3.3.1 Direct Impacts

Direct impacts to land uses and cover types are the changes in existing patterns which will result from the actual occupation of land by mine pits, processing facilities, waste dumps and tailing basins, lean ore stockpiles, and other related mine uses. Because of the location of the copper-nickel deposits (Figure 6), the land required for these uses will generally have to come from land which is presently not classified as mineland. The actual amount and types of land which will be affected depends, of course, on the size and type of the mine development, the final sites selected, and the number of mines developed.

3.3.1.1 Copper-Nickel Development Area--The general area in which direct impacts are expected to occur is shown in Figure 4. It is roughly a six-mile wide corridor which includes an inner zone called the Copper-Nickel Resource Area. The entire corridor is referred to as the Copper-Nickel Development Area. The Copper-Nickel Resource Area is an 88,600 acre (35,870 ha), 3-mile wide strip of

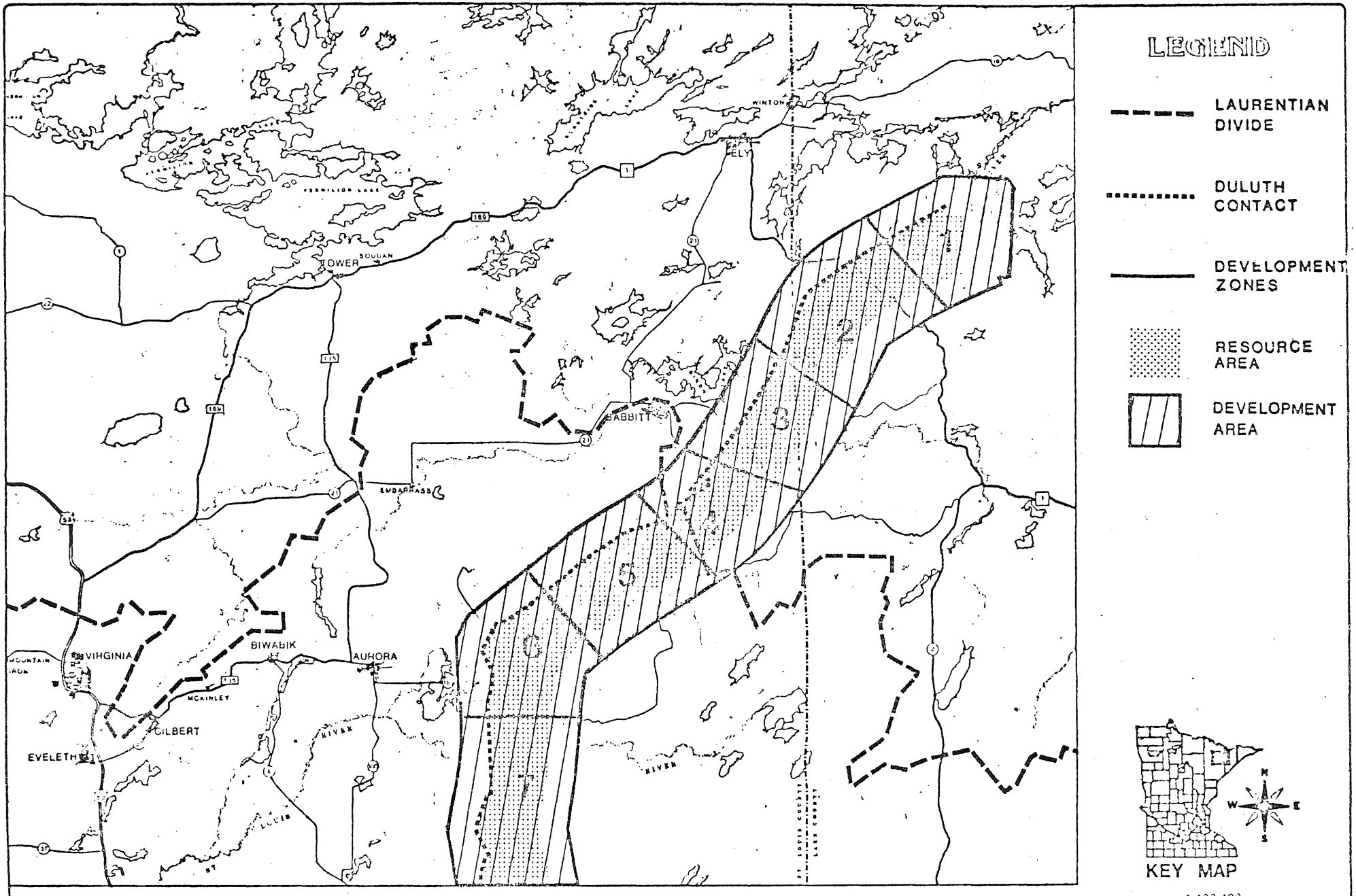


FIGURE 4

MEQB REGIONAL COPPER-NICKEL STUDY

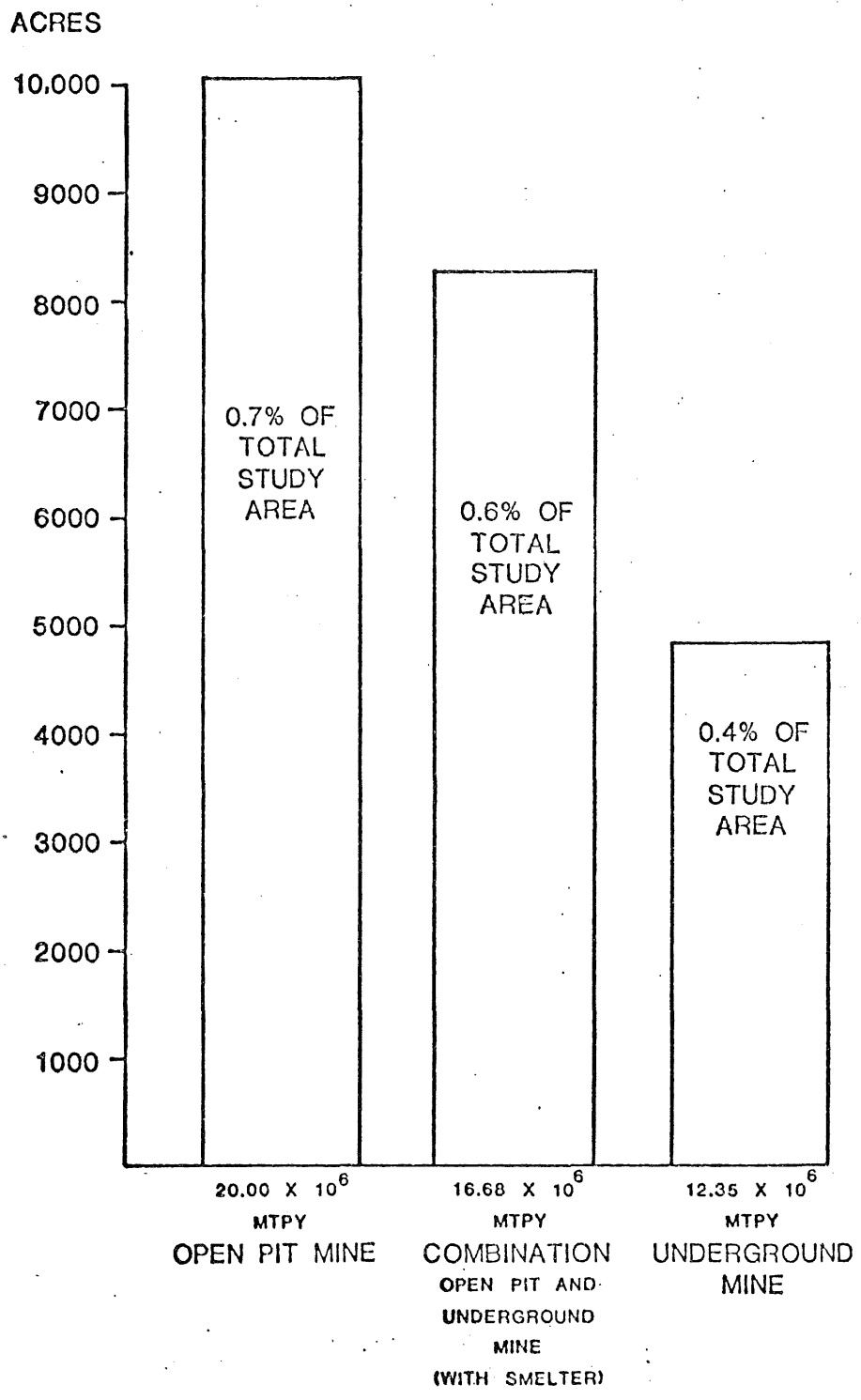
MN CU-NI DEVELOPMENT AND RESOURCE ZONES

land representing roughly 6% of the Study Area and which extends east from the basal contact of the Duluth Complex where all actual extraction of ore will occur in the forseeable future. This is also the zone which, in addition to the actual pits and mineshafts, would be the most likely location for ore processing facilities such as crushing, grinding, and flotation plants. The remaining 86,320 acres (34,947 ha) of the Copper-Nickel Development Area extends one and one-half miles beyond the resource area and represents the limits within which the transportation of waste materials and lean ore intended for dumping and stockpiling is economically desirable. Tailings can be piped ten miles or more from the processing plant, which means that tailing basins could be sited outside of the development area, although at a significant economic cost. The assumption here is that tailing disposal will likely occur as close as possible to the processing plant.

Certain lands in this area are not currently liable to direct occupation for mining purposes. The types of land falling into this category include water covered land (other than very small streams and lakes), all publicly managed land within 400 feet of the shore of a lake or stream (as implied by the Shipstead-Nolan Act of 1934) in zones 1 to 3, all land within the BWCA, and land within the Keeley Creek Research and Natural Area (administered by the USFS).

3.3.1.2 Land Requirements of Copper-Nickel Mine Development--Land requirements for a copper-nickel operation vary primarily with production capacity and mining method. Underground mining requires less land because no large open pits are required; therefore, there is less waste rock to dispose of. Generally speaking, as the production capacity of a mine increases, the amount of land required also increases.

FIGURE 5 LAND REQUIREMENTS FOR THREE HYPOTHETICAL COPPER-NICKEL MINING OPERATIONS



SOURCE: REGIONAL COPPER-NICKEL STUDY TECHNICAL ASSESSMENT TEAM

The hypothetical fully integrated mine models (mine, mill, smelter, and refinery) presented in Volume 2-Chapter 5 range in size from the estimated 2,232 acres required for a 5.35 X 10^6 mtpy underground mine (no smelter or refinery) to an estimated 10,241 acres required for a 20.00 X 10^6 mtpy open pit mine (Figure 5). The actual land requirements for a mine operation will vary depending on other factors as well, such as the height and number of waste dumps and lean ore stockpiles, the ratio of wasterock and lean ore to usable ore, the depth and number of tailing basins, and adjustments in the spaces between facilities.

3.3.2 Secondary Impacts

Associated with copper-nickel mine development will be a parallel growth in the service sectors of the Study Area economy. Population increases resulting from new job opportunities in not only the mining industry but in an expanded service industry as well will in turn stimulate the growth of residential settlement in the Study Area. This growth in residential settlement coupled with a corresponding increase in the amount of land consumed by associated urban uses will result in an overall growth in land devoted to residential, commercial, transportation, and utility uses.

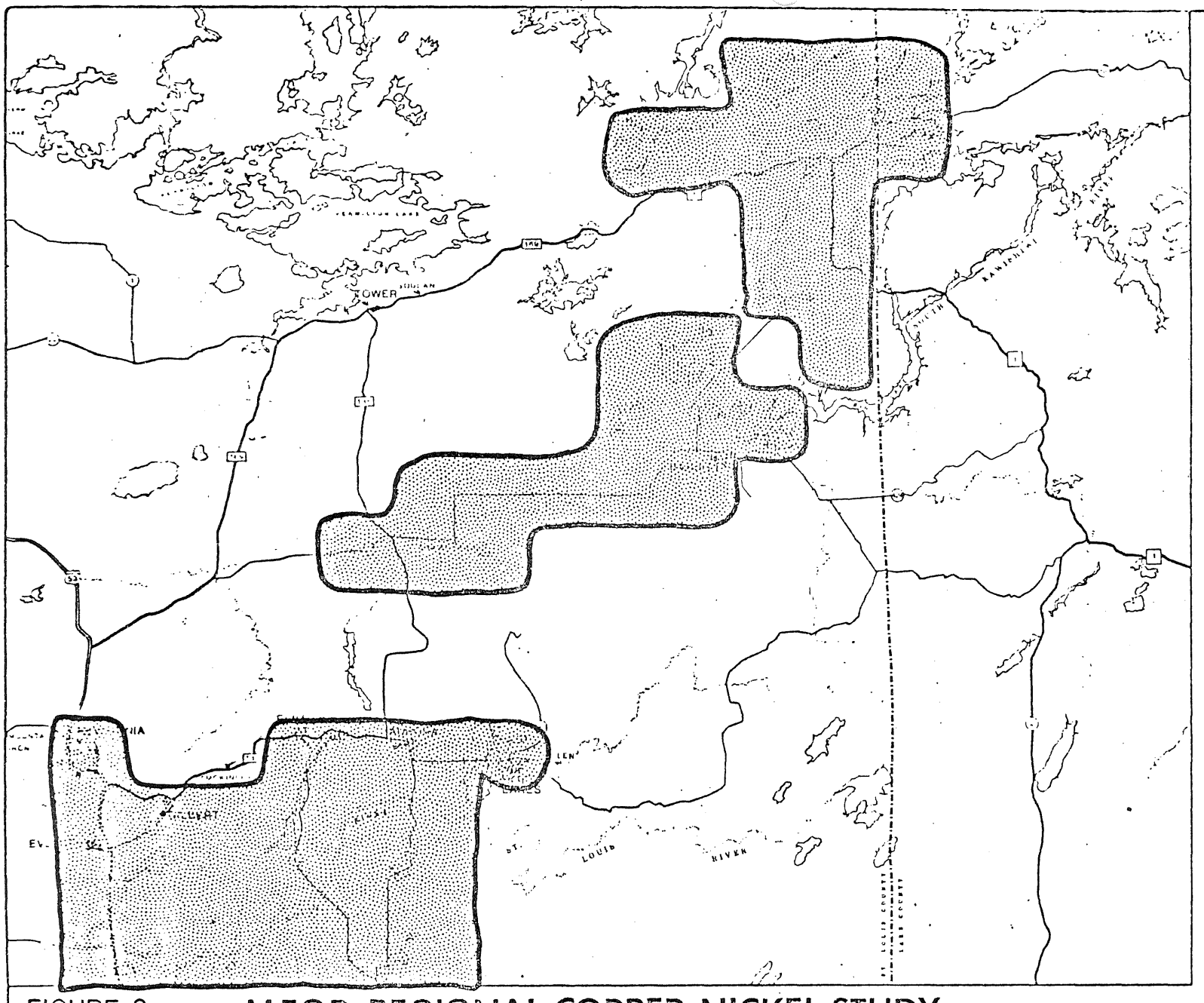
3.3.2.1 Population Growth--Assuming expansion in the taconite industry and the development of three copper-nickel mines (an underground operation at the northern end of the Resource Area, a combination underground/open pit operation in the middle section of the Resource Area, and an open pit operation at the southern end) Study Area population is projected to increase approximately 55% over 1976 levels from an estimated 50,190 in 1976 to a projected 77,940 at the peak of production (see Volume 5-Chapter 7, Regional Copper-Nickel Study Residential Settlement Model). Major land use-land cover implications of this

population growth include the almost certain increases in traffic levels, use of recreational lands and facilities, and energy consumption along with increases in the amount of land consumed by residential/commercial land uses.

3.3.2.2 Residential Settlement Growth--Projections based on the 3 hypothetical mining operations show an additional 8,272 acres (3,349 ha) of land being consumed for residential purposes alone. While this amounts to only a 28% increase over the 29,400 acres (11,903 ha) presently classified as residential/commercial (compared to the 55% increase in population), new commercial development will result in additional consumption of land which is presently not used for residential/commercial purposes (estimates of current acreages in residential/commercial use may be somewhat high due to the fact that they were calculated in terms of the number of 40 acre parcels dominated by residential or commercial use).

While 71% of Study Area population growth is expected to occur in 9 Study Area cities, 61% of the land consumed by new residential settlement is projected to come from land in areas currently considered rural. This is mostly as a result of the minimum residential lot sizes allowed in municipal zoning ordinances which are generally much smaller than the minimum lot size requirements in the county zoning ordinances.

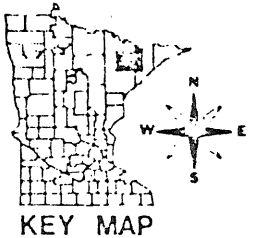
Projections made using the Residential Settlement Distribution Model show 90% of all new residential growth (in terms of new residences) occurring in 3 sections of the Study Area amounting to 20% of Study Area land (Figure 6). Of these 3 areas, the Ely area is expected to show the greatest increase in residential settlement despite the fact that only 25% of the new growth is projected to occur there (compared to the 48% of new households which are expected to settle in the



LEGEND

SOURCE:

REGIONAL COPPER-NICKEL STUDY RESIDENTIAL SETTLEMENT MODEL



KEY MAP

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FIGURE 6

MEQB REGIONAL COPPER-NICKEL STUDY

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

southwest section of the Study Area between Virginia and Hoyt Lakes). At peak production, the number of households in the Ely area is expected to be roughly 65% greater than it was in 1976 compared to the 35% increase projected in the Virginia-Hoyt Lakes corridor.

Increases in the amount of land used for residential/commercial purposes will not only mean decreases in land available for other uses, but may potentially alter the characteristics of areas not directly consumed such that the capacity of these lands to support uses such as certain types of hunting, snowmobiling, and forestry, for example, may be impaired.

3.4 GENERAL LAND USE-LAND COVER IMPACTS TO YEAR 2000

The two major types of impact generators (direct and secondary) will ultimately change the overall land use-land cover patterns in the Study Area provided new mine development occurs. Apart from the potential copper-nickel developments, there is also the possibility of expansion in the taconite industry which would change land use-land cover patterns in the same fashion as the copper-nickel developments. Due to the uncertainty surrounding future taconite expansion, land cover changes attributable to this expansion have been calculated and presented separately in this section in the event that the reader may choose to disregard them because of shifts in taconite development plans. Summaries of projected land cover changes are presented in Table 2 and Figure 7.

Following the presentation of projected land cover changes, there is a brief discussion of the general significance of these changes in terms of their implication to major land uses and to the human environment of the Study Area. Land use impacts, including any impacts caused by noise, water, or air quality changes, are more completely analyzed for specific categories of use in chapters 4 through 10 of this volume.

Table 2. Land cover projected for 2000.

LAND USE	1977 ACRES	% TOTAL ACRES	PROJECTED ACREAGE CHANGE BY YEAR 2000	% CHANGE FROM 1977	% TOTAL ACRES 2000
Minelands			+23,213 (Cu-Ni)[a]	+52.3	5
	44,360	3	+7,400 (TAC)[b]	+16.7	4
			+30,613 (combined)	+69.0	5
Water			0 (Cu-Ni)	0.0	8
	109,480	8	+10,280 (TAC)[b]	+9.4	9
Residential/			+13,997 (Cu-Ni)[c]	+47.6	3
Commercial	29,400	2	+2,268 (TAC)[c]	+7.7	2
			+16,265 (combined)[c]	+55.3	3
Transportation	1,520	*	+600 (Cu-Ni)	+39.5	*
Agricultural			-1,036 (Cu-Ni)	-3.8	2
	27,320	2	-168 (TAC)[d]	-0.6	2
			-1,204 (combined)	-4.4	2
Pasture/Open			-1,036 (Cu-Ni)	-2.2	3
	47,880	4	-168 (TAC)[d]	-0.4	3
			-1,204 (combined)	-2.6	3
Forest			-34,541 (Cu-Ni)	-3.3	74
	1,049,360	77	-18,492 (TAC)[e]	-1.8	76
			-53,033 (combined)	-5.1	73
Swamp			-597 (Cu-Ni)	-1.1	4
	54,840	4	-1,120 (TAC)[e]	-2.0	4
			-1,717 (combined)	-3.1	4

*Less than 1%.

[a]Based on "3-zone" hypothetical mine model.

[b]Based on testimony presented at hearing for Certificate of Need by Minnesota Power and Light and United Power Assoc. 1977.

[c]Derived by multiplying new population (27,770) by "urban" land per capita calculated by dividing existing "urban" acreage by existing population.

[d]New res./comm. land was allocated among agric., open, and forest land by assigning it to each classification according to the amount of available land (7% in ag. and open, 86% in forest) in each category.

[e]In addition to the res./comm. land taken from forests, new water and minelands were subtracted from these uses in two ways:

1) Cu-Ni minelands were subtracted according to the ratio of swamp to forest in each appropriate Development Zone.
2) Taconite minelands were subtracted by analyzing land uses within the proposed expansion areas.

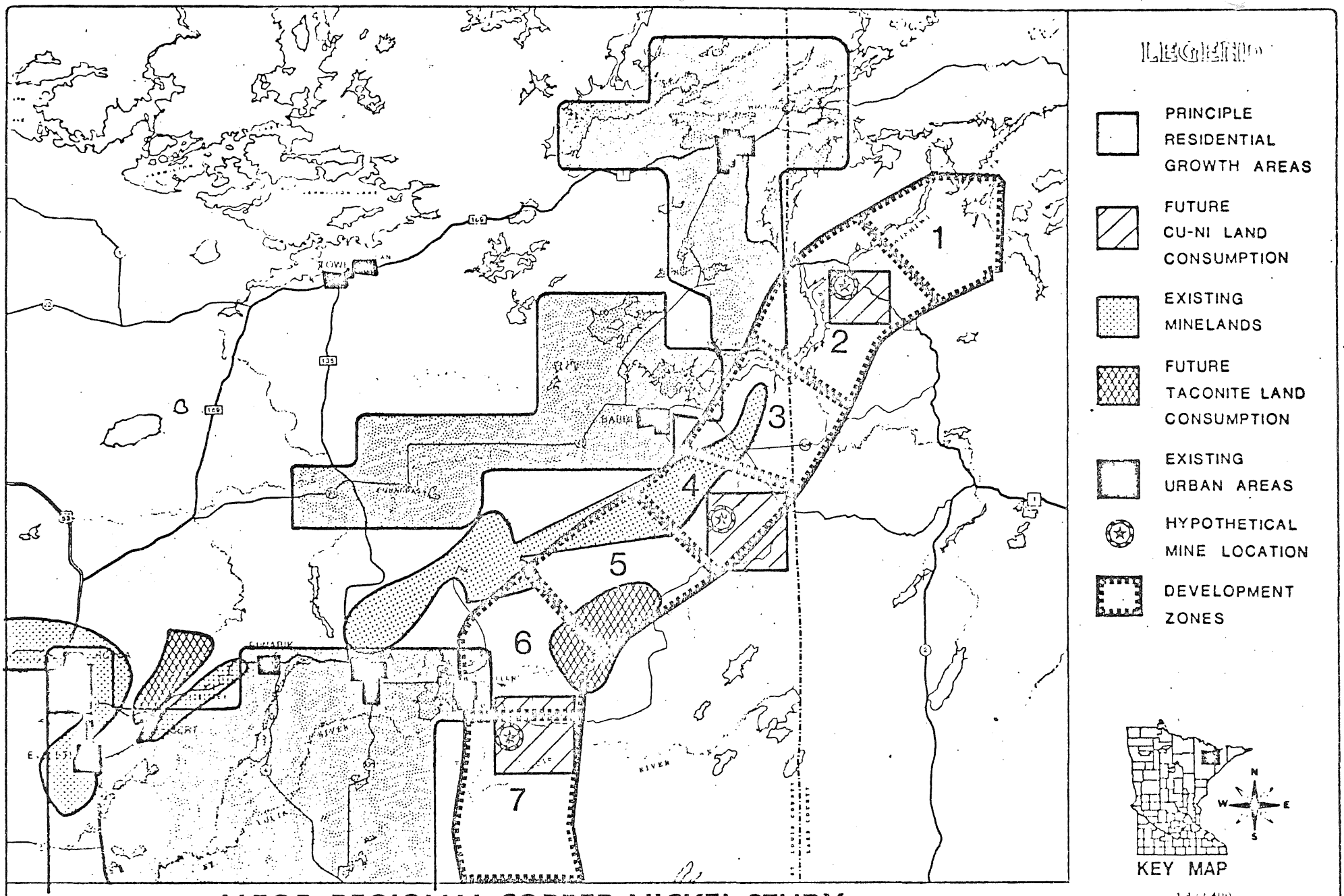

FIGURE 7 MEQB REGIONAL COPPER-NICKEL STUDY

HYPOTHETICAL LAND USE SCENARIO- YEAR 2000

3.4.1 Hypothetical Land Cover Patterns for Year 2000

3.4.1.1 Mineland--The 44,360 acres (17,960 ha) of land currently used for mining purposes occupies 3% of all land in the Study Area. Assuming the development of 3 hypothetical copper-nickel operations [a 12.35 X 10^6 mtpy underground mine and mill in Zone 2; a 16.68 X 10^6 mtpy combination underground and open pit mine, mill, and smelter in Zone 4; and a 20.00 X 10^6 mtpy open pit mine and mill in Zone 7 (Figure 5)], approximately 23,213 acres (9,398 ha) of new minelands (occupying 2% of the Study Area) would be required. This additional acreage would amount to a 52.3% increase in the extent of Study Area minelands and would increase the overall percentage of land in the Study Area that is devoted to mining to 5%. A large majority of land (84%) in Development Zones 2, 4, and 7 is forest and swampland. As such, it can be reasonably expected that the increases in mine use will come mostly at the expense of forest and swamp areas. An illustration of the gross acreage in each zone that will convert to mining is presented in Figure 7 (note that the areas depicted in Figure 7 as new copper-nickel areas do not represent actual proposed mine configurations).

Tentative taconite expansion plans indicate an increase of approximately 7,400 acres (2,996 ha) for pits, tailing basins, and related uses. This would be a 16.7% increase over existing minelands. Figure 7 indicates the general locations of these new taconite lands. As with the areas in which copper-nickel mining is expected to occur, the areas of potential taconite expansion are predominantly forest and swampland, hence any increase in taconite mining land use is expected to be accompanied by a simultaneous decrease in Study Area forest and swamp lands.

If the hypothetical copper-nickel and taconite expansion developments both occur at the magnitudes projected, the result would be an approximate 69% increase in

the amount of land occupied by mining uses. This would mean that roughly 74,973 acres (30,353 ha) or 5% of the Study Area land would be classified as mineland.

3.4.1.2 Water--The tentative taconite expansion proposals include approximately 10,280 acres (4,162 ha) of new reservoirs that may be added to the water area of the Study Area. This represents a 9% increase over present acreages of water covered land in the Study Area. Reservoirs are not included in the land requirements for copper-nickel mining, but may become necessary if tailing basins cannot adequately double for this purpose. Copper-nickel reservoirs may add another 6,000 to 8,000 acres (2,429 to 3,239 ha) to this land cover type (up to a 7% increase).

3.4.1.3 Residential/Commercial--Development of the three model hypothetical copper-nickel mining operations would result in an estimated inmigration of 23,886 new residents to the Study Area. Roughly speaking, half of these new residents would be employed in an expanded service sector of the economy and half would be mine employees. Projections based on an urban land per capita figure (0.586 acres per capita--derived by dividing the acres of existing residential/commercial land in the Study Area by current population estimates) show an increase of about 14,000 acres (5,668 ha) or 47.6% over current acreages of land used for residential or commercial purposes.

The distribution of that portion of the additional residential/commercial land which would be consumed for residential purposes is discussed more completely in Chapter 7 of this volume. Figure 6, however, presents those portions of the Study Area which are projected to receive 90% of the new residential settlement resulting from the 3 hypothetical copper-nickel mines. Figures (presented in Chapter 7) based on the minimum lot size requirements contained in zoning ordi-

nances in the Study Area place the estimated consumption of land for residential purposes at about 8,275 acres (3,350 ha). It is assumed that most of the remaining 5,725 acres (2,318 ha) of new residential/commercial land would be land consumed in the major urban areas for new commercial uses.

Study Area population increases which would result from expansion in the taconite industry are estimated to be about 3,870 new residents. At the previously mentioned land consumption rate of 0.586 acres per capita, this population increase would result in 2,268 acres (918 ha) of land presently used for other purposes being converted to residential/commercial uses. Because this population increase would be a result of expansion in existing employment centers, it is expected that the distribution of this new settlement would follow existing settlement patterns.

Together, taconite expansion and the development of the 3 hypothetical copper-nickel mines would add about 16,265 acres (6,585 ha) of residential/commercial land uses to the 29,400 acres (11,903 ha) currently in this category. This would be an increase of 55.3% and would mean that residential/commercial land uses would account for 3% of the land area of the Study Area, up from the present 2%.

3.4.1.4 Agriculture--Part of the increase in the amount of residential land in the Study Area is expected to come at the expense of lands currently classified as agricultural. The remainder of the new residential/commercial lands are expected to be taken from existing pasture/open lands and forest lands. That portion of the new residential/commercial land which would replace agricultural land was estimated by determining the percentage of all land available for development (privately owned non-mine land which is within one mile of an existing road) in these three classifications which is presently used for agricultural

purposes and applying this percentage to new residential/commercial land. These calculations suggest that about 7.4% (1,204 acres, 487 ha) of new residential/commercial land would displace agricultural land. This represents only a 4.4% decrease in the amount of agricultural land in the Study Area, lowering the proportion of all Study Area lands classified as agricultural only slightly.

3.4.1.5 Pasture/Open Land--Another 7.4% of available land in areas currently classified as agricultural, forest, and pasture/open lands is located in pasture/open lands. Using the procedure outlined above, it is estimated that about 1,204 acres (487 ha) of pasture/open land would be displaced by new residential/commercial development. This amounts to a 2.4% decrease in land of this type.

3.4.1.6 Forest--Almost 93% of all land consumed by the development of new mining and residential/commercial land uses is projected to be in areas which are presently classified as forest. This proportion holds true for copper-nickel, taconite, or combined copper-nickel and taconite development. Of the 37,210 acres (15,065 ha) of land which are expected to change to mining and residential/commercial uses in the event that 3 copper-nickel mining operations are developed, 34,541 acres (13,984 ha) of this land is expected to displace lands which are currently forested. This would be a 3.3% decrease in the amount of land devoted to this use and would lower the overall percentage of Study Area land in a forest classification from 77% to 74%. These figures could change slightly depending on the actual siting of the copper-nickel mine components themselves.

Taconite expansion of the magnitude considered would displace another 18,492 acres (7,487 ha) of forested land primarily in the area along the Biwabik Iron

Formation just northeast of Virginia and in an area just northeast of Hoyt Lakes. The consumption of this land would mean a 1.8% decrease in lands devoted to forest use.

In the event that both copper-nickel and taconite developments occur, estimates are that about 53,033 acres (21,471 ha) of forest land would be converted to either mining/ residential/commercial, or water covered lands. This would represent a 5.1% decrease in forest lands in the Study Area and would lower the percentage of all Study Area lands which are forested from 77% to 73%.

3.4.1.7 Bogs and Swamps--If it is assumed that no residential/commercial land consumption will occur on permanently wet bog and swamp lands, the total estimated amount of swampland displaced should copper-nickel mining occur in 3 locations and taconite expansion take place as proposed, would be 1,717 acres (695 ha). This would be a 3.1% decrease in lands of this classification. Federal laws pertaining to solid waste disposal could prohibit the use of "wetlands" for certain mining land uses (see Volume 5-Chapter 5 for more information on this issue).

3.4.1.8 Transportation--Although future growth in the mining industry would result in heavier traffic volumes on Study Area highways and railroads, the consumption of land for new or expanded transportation corridors is expected to be minimal. The difficulty in assessing transportation as a land cover is that the acreages presented in Table 1 have been compiled by MLMIS (Minnesota Land Management Information Service) on the basis of dominant land use in a 40-acre parcel. Transportation corridors, such as highways and railways, are rarely the dominant use in a 40-acre parcel with the result that these transportation uses are not completely reflected in the overall transportation classification.

Several new transportation corridors are likely in the Study Area by the year 2000. Development of copper-nickel mining could prompt the construction of 15 to 50 new miles of spur railways to connect the mines with existing routes. These railways, assuming a 100-foot right-of-way, would consume from 180 to 600 acres. A proposed public road (by AMAX, Inc.) linked to mining in Zone 4 would stretch from 10 to 15 miles roughly between Babbitt and Hoyt Lakes. This road would consume roughly 90 acres (36 ha) of land assuming a 50-foot right-of-way. Finally, a new Forest Highway (FH 11) has been proposed to link Hoyt Lakes with Silver Bay. This project would require both the upgrading of several miles of existing Study Area roads and the construction of roughly 10 new miles of road. This proposal could mean an additional 75 acres (30 ha) of new transportation uses. In addition to new rail and automotive corridors, mine development and related secondary growth would most likely generate a need for new transmission lines to deliver power to new customers. Estimates of the land required for new transmission lines (based on hypothetical development scenarios presented in Volume 5-Chapter 11) range from 660 acres to 2,295 acres.

3.4.2 Analysis of Land Use Changes 1977-2000

Changes in the land cover categories described in the previous section reflect the general physical impacts to the Study Area human environment resulting from development of copper-nickel resources and possible expansion in the existing taconite industry. Recalling the relationship between land cover and land use, the projected land cover changes suggest the types of uses that will either be inhibited or diminished. Also suggested are some of the land use policy conflicts in which government and special interest groups will be involved in the future.

3.4.2.1 Implications of Increases in Mineland and Residential/Commercial Land Cover Categories--Mineland and residential/commercial land cover types generally include large areas covered by man-made physical features which are incompatible with those uses requiring access to the soil such as agriculture or commercial forestry and tend to inhibit those uses which require large, undeveloped tracts of land such as some forms of recreation, wildlife management, and wilderness preservation.

While the direct consumption of land for new and expanded mine developments is projected to be larger in terms of actual acres affected--30,613 acres for mining compared to 16,265 acres for new residential/commercial uses--these impacts will be relatively more localized in the Development Area than will the secondary impacts of land consumption for new residential settlement which will be distributed throughout the Study Area as summarized in Figure 7. As a result, it can be expected that new residential settlement will more generally and noticeably interfere with those uses requiring large, relatively undisturbed tracts of land. This will be particularly true in the areas around Ely and in the Embarrass Valley which are currently less settled than the southwest section of the Study Area between Virginia and Hoyt Lakes and which are projected to see a larger percentage increase in settlement. Increases in the population and acres devoted to residential purposes in these areas will almost certainly add user pressure to recreational facilities. Interference with forestry and wildlife management may disrupt certain forest management techniques or alter habitats so that certain types of wildlife must either adapt to the higher level of human presence or seek more suitable conditions elsewhere. These possible impacts are aggravated by the likelihood that much residential settlement in these areas is expected to be of a dispersed nature characterized by residences

developed on large lots at very low densities along roads and highways. This would effectively distribute the impacts of an actually smaller consumption of land over a relatively larger area.

It also should be noted that the reclamation of at least some of the consumed minelands could return these acres to a new productive use and, eventually, even to commercial forest suitability.