HISTORY OF THE MINNESOTA RESOURCES COMMISSION COPPER-NICKEL STUDY

On January 27, 1972, the Governor requested the formation of an Inter-Agency Task Force on base metal mining impacts in Minnesota. This executive initiative resulted in a comprehensive review of state mineral policy, regulatory powers of the state, mineral potential, metal markets, mining methods and processes of benificiation, reduction and refining, potential environmental impacts, potential economic impacts, and attitudes of state residents toward economic development and environmental protection in northern Minnesota. The Task Force report released in January 1973 did provide the first comprehensive discussion of the issues that would be involved in a copper-nickel development decision. However, it was not the charge of the Task Force to conduct a detailed analysis of environmental and socio-economic impacts.

Accordingly, during the 1973 session of the Legislature, the Minnesota Resources Commission (MRC) appropriated $100,000 to the Minnesota State Planning Agency for a copper-nickel study. Chapter 720; sec. 43; Subdivision 9; Subparagraph f of the Laws of Minnesota for 1973 states:

> The Department of Natural Resources, the University of Minnesota and the State Planning Agency will report to the legislature on the economic needs and problems related to the development of a copper-nickel industry in Minnesota and the environmental impact of the various development proposals.

This initiative by the Legislature, which was in part based on the Task Force report and its recommendations, represented legislative recognition that a detailed analysis of base metal mining impacts should be conducted prior to the introduction of such an industry in Minnesota. Such anticipatory action by the Legislature suggested their concern that the State be able to avoid or minimize adverse environmental and socio-economic impacts and simultaneously be able to make an informed decision about the use of this mineral resource. Furthermore,

the initiative clearly signals the legitimate intent of the legislature to be involved in this natural resource decision. Anticipatory planning for major development decisions has not been a frequent occurrence at either the federal, state or local levels of government. Consequently, the action taken on the copper-nickel issue by both the Governor and Legislature of this State is in a sense historic and clearly what is necessary for wise use of the State's natural resources.

On January 31, 1974 a Cu-Ni study proposal was submitted to and approved by the MRC. That proposal outlined four components of the study. The components are: a socio-economic assessment, an environmental assessment, the design of a regional monitoring program, and a technology assessment.

In addition to the four major components three additional studies were initiated in the work program: (1) an analysis of world supply and demand for copper nickel (2) a study of bedrock geology, mineral potential and mineral leases in the Arrowhead region of Minnesota and (3) the development of Cu-Ni mining models which illustrate the inputs and outputs of alternative mining and refining technologies.

The enclosed document is a summary of the findings of the socio-economic assessment and the international supply and demand for copper-nickel. Unfortunately summary statements are too brief to reflect all the findings of studies such as this. Persons interested in methods, data collection techniques and analytic assumptions are encouraged to read the technical reports.

THE NATURE OF THE SOCIO-ECONOMIC ASSESSMENT

Introduction

The proposed mining of copper-nickel ores in the Arrowhead Region has the potential for significant influence on the future socio-economic characteristics

of that area. New industrial activity is accompanied by increased employment, population, and governmental revenue. At the same time, however, mining development may entail costs for the provision of governmental services or costs in terms of environmental harm. A myriad of policy choices for governmental action is available for balacing costs against benefits of mining activity. What is needed is a means for evaluating the alternative choices to determine the relative magnitudes of the foreseeable impacts as a foundation for rational decision making.

This assessment is intended to provide some essentials of that foundation. Its purpose is the identification of cause-effect relationships between copper-nickel mining development and selected socio-economic characteristics in the Arrowhead Region. It is intended to present some methodological approaches and plausible answers to the following questions:

-How will mining development affect future regional employment? unemployment? population?

-What revenues may the state expect from different levels of copper-nickel development?

-What kind of capital expenditures will be necessary to provide services for future human and industrial needs?

The analysis proceeds by using available data to suggest what may be reasonably expected impacts of alternative levels of copper-nickel development. The analysis is also applied to an optional scheme of development consisting of the introduction of new public administration jobs to the Arrowhead region. This variation allows the decision-makers to compare mining development with other, non-mining types of regional development strategies.

The analysis has focused on the Arrowhead <u>regional</u> economic system and its development prospects. The reason for this regional perspective is that copper-nickel mining development does not occur in a vacuum, but rather interacts with

other development committments and opportunities such as taconite mining expansion, recreation industry growth, and service and trade employment growth.

FINDINGS: INTERNATIONAL SUPPLY AND DEMAND COPPER AND NICKEL

The Market for Copper

Although the availability of substitute materials and technologies suggest that demand should be relatively sensitive to price, the importance of copper in the world market reduces that sensitivity to some extent. In the long-run, however, because of substitution, copper demand will probably be more sensitive to price than it has been in the past.

Mineral "reserves" are defined as those deposits that are profitably mined at current prices. Thus, the extent of world copper "reserves" depends upon the state of the mining art as well as the price of copper. Despite the resulting dynamic nature of reserves, it is important to note that U.S. domestic reserves represent close to one quarter of the world total. Communist nations possess only very small reserves.

The nations most important for mineral supply assessment are those with the largest reserves. The political and economic environments of these nations have great potential impact upon reliability and/or availability of supplies.

The U.S. is largely self-sufficient in copper, producing 21% while consuming 26% of the world total. Reserves of 24% of the world total closely approximate its historical consumption share.

Chile has the second most abundant reserves, with 16%. It accounts for about 10% of world production, almost all of which it exports. Although the Chilean government under Salvador Allende effected large scale expropriation of foreign investments, recent trends by the present government indicate return to more market-oriented economics. Although the copper industry has been nationalized,

diverting some market power to the government, the new government has not chosen to utilize that position for political ends.

The U.S.S.R., which has about one-tenth of the world's reserves, one-seventh of the world's production, consumes about 13% of world supplies. Thus, the U.S.S.R. is largely self-sufficient, and non-competing with the U.S. in world markets.

Canada produces about 11% of world total from deposits representing 4% of world copper reserves. Consumption is small, allowing Canada to be a large exporter to both Japan and the U.S. There does not seem to be much danger that Canadian supplies to the U.S. will be curtailed.

Zambia, Zaire, and Peru are other large-reserve nations, with world shares of 8%, 7% and 6% respectively. All three nations have experienced nationalization of their copper industries to some extent, but national development goals have undercut the ability of any of these governments to wield significant world market power.

Chile, Zambia, Peru and Zaire have joined together in an organization of copper-exporting countries, CIPEC. The four nations have an aggregate of 37% of world reserves and a combined 1973 production of 29% of global mine output; they consume less than 1% of world refined copper. Despite the banding together of these nations, it does not appear likely that they will command sufficient market power to duplicate the highly effective cartel-embargo actions of OPEC, the oil producing group. The CIPEC nations have wrested some market power from the formerly dominant multinational corporations, but indications are that they have been unable to assert this power to their own advantage. CIPEC has suffered from a lack of coordinated power and from a lack of trade independence necessary for clout. The result has been a balancing of the market power between the CIPEC group and the MNC's--making for a relatively free trade in copper. This balancing

of market powers is expected to continue, and thus, the danger to consumer nations of a copper-embargo seems rather remote.

Although the copper industry has traditionally been highly integrated and concentrated, a number of trends have developed over the past 10-15 years to dilute the strength of the natural oligopoly. Large market shares have been placed in the hands of nationalist governments. For other reasons, these nations have been unable to assert their market power, and it appears they will not be able to do so in the future.

The availability of copper supply depends on many additional factors, such as technological advances, price, recycling efforts, and population. On balance, there seems to be little danger of supply shortage in the foreseeable future, either from market imperfections or from technological road blocks. In 1971, world reserves had a 53 year supply lifetime at 1971 production levels. Given the willingness of consumers to pay the expected higher real costs of extraction and recycling, world copper resources should not be exhausted in 50 years, but rather, should continue to remain available and plentiful for centuries.

Copper prices should reflect closely the real costs of production, since the balancing of interests should keep the copper market near free-market operation. Simple extrapolation of past trends indicates that copper prices should increase about 250% by the end of the century. Perhaps more realistically, the price (adjusted for inflation) will increase 4 to 5 times 1970 levels. In the first case, the average annual increase would be about 3% while in the latter case, the annual real increase would be about 5.5% . These annual increases should be valuable in making decisions about timing for any development of domestic copper mining activities.

It is expected that the U.S. willcontinue its present share of world consumption for the rest of the century. Increasing domestic dependence upon foreign sources of copper does not appear to be a worrisome situation. The U.S. does not face dangers of copper dependence similar to those found in the case of oil.

The Market for Nickel

Despite the importance of nickel as an alloying material in steel, and hence its importance in military applications, there are alternative materials available to replace nickel in essentially all of its uses. Although these substitutes suggest nickel demand sensitivity to price, the importance of the metal and the cost of alternatives operate to make consumption less dependent on price. In the long run, the demand for nickel, like that for copper, will be more sensitive to price.

U.S. nickel "reserves", as estimated in 1970, represent a relatively insignificant portion of the world total. The U.S. produces virtually none of the nickel it uses. Present domestic production involves one small mine in Oregon. Most U.S. domestic needs are met by extensive Canadian resources.

The 1970 "reserve" data must be qualified. Improvements in exploratory, recovery, and processing technologies accounted for a five-fold expansion of "reserves" in the decade 1960-1970. It is assumed that further rapid developments will take place. Additional identified resources are likely to become "reserves" in the future. Resource distribution suggests that the 1970 reserve allocation among nations is subject to some error. Nickel resources of the U.S., mostly because of the huge Duluth Gabbro formation, are considerably more significant vis-a-vis the rest of the world than would be expected from the 1970 "reserve" data. If identified resources are examined, the U.S. deposits, including those in

Minnesota, represent about 17% of world total. If Minnesota is excluded, U.S. identified resources represent about 2% of world total. Thus, Minnesota's position in the world nickel market is very important.

It is important to note that world nickel resources are vast. Even under the conservative 1970 reserve estimates, world consumption at 1970 levels could not be satisfied from primary sources for 120 years. Under more liberal interpretations of nickel supplies, this lifetime could be extended to about 200 years. If recycling is taken into account, these estimates expand considerably. Recovery of secondary materials has been expanding, from about 8% of consumption in 1960, to about 22% in 1972. In-use nickel represents a very substantial domestic resource.

Cuba possesses almost one quarter of identified global nickel resources, although its production accounts for only 5% of world output. The U.S.S.R. also possesses significant nickel deposits. Together, the Communist nations control about 1/3 of world resources. Traditional chilly relationships between the U.S. and these nations have frustrated trade, but at the same time, have prevented U.S. dependence.

New Caledonia possesses substantial nickel reserves, perhaps up to 22% of world total. New Caledonia is a French overseas territory that accounts for about 15% of world production. Most of this nickel is shipped to Japan. French and Japanese influence seem to dominate there, so that New Caledonian nickel, although increasing, has not yet become a major American source of supply.

Canadian nickel represents the most important source of U.S. supply. Canada possesses up to 20% of world nickel endowments, and 37% of this is exported to the U.S. It is expected that the export-oriented nickel industry of Canada will continueto be the primary supplier of American nickel needs for the

foreseeable future. Canadian mine production in 1973 was nearly 1.5 times the total consumption of nickel in all of North and South American during that same year.

Indonesia, the Phillipines, and Australia possess approximately equal resource shares, from 5 to 10 percent of world totals. The market thus breaks down as follows: Communists control about 1/3 of world resources, developing nations possess another third, and the last third is distributed among developed Western nations.

This division of market power is one reason why an OPEC-type organization in nickel is extremely unlikely. Another is that collusion is not compatible with economic development goals of the nickel-rich nations. Third, no group seems likely to amass market power sufficient to allow collusive action for political or economic purposes. A cartel or embargo is extremely improbable.

The nickel industry, like that of copper, is characterized by concentration, a high degree of vertical integration, and barriers to entry. The concentration in the nickel industry is high: one firm, INCO, has over one half of the world market, and the top five firms control together about 85%. In terms of production capacity, concentration is even greater. The market strength of the large nickel producers is likely to continue in the foreseeable future. The natural producer oligopoly seems secure, and although some excess, or non-economic profits may be generated, unusually large barriers to entry make this the most economically practical and efficient means of production.

Supply availability of nickel, like copper, depends on technological advances and prices. The most salient feature of supply availability is the truly enormous resource endownment. If the Duluth Gabbro deposits are included, domestic supply lifetime is almost 100 years. Without the Minnesota deposits, domestic supply is lowered to about 10 years.

Like those of nickel, copper prices should reflect the real costs of production and recycling; the main difference is that some oligopolistic profits will tend to keep nickel prices above real costs by a steady margin. INCO maintains strong price leadership. A sudden demand insensitivity to price, such as occasioned by war, could translate into inflation of nickel prices, but the seemingly secure nature of supply channels would operate to maintain supplies. 1970 Bureau of Mines predictions suggest that real prices of nickel will rise by only 15% during the next quarter century. Perhaps it is more realistic to assume that prices will double by then. In either case, the average annual increase will be relatively slight, less than 2½%.

It is likely that the U.S. will maintain a dominant place in the consumption of nickel. Its consumption share should remain stable or decrease only slightly. The extent of the U.S. domestic nickel supply depends primarily upon the exploitability, both economic and political, of the Minnesota deposits. If they are exploitable, U.S. domestic supply becomes significant vis-a-vis the rest of the world. If not, the U.S. has a very small domestic endowment.

There does not seem to be a significant threat of supply curtailment by economic nationalists. Foreign supplies seem secure at prices dictated in an oligopolistic nickel market.

FINDINGS: SOCIAL SERVICE INVENTORY

Population Distribution

Examination of population changes between 1960 and 1970 reveals concentrations of people in two major locations: 1) the iron range and 2) the port cities. It also reveals a general decrease in the populations of the municipalities as well as the region while the state population has increased considerably during the same period.

In contrast to the other municipalities, Babbit and Hoyt Lakes have experienced population increases in the base period. These relative anomalies are accounted for by taconite expansion: the development of the Reserve mining pit at Babbit and the Erie mining operation at Hoyt Lakes.

Service Centers

A description of the regional service infrastructure is aided greatly by the identification and description of service centers. Information has been organized and evaluated through a classification scheme, proposed and employed by the Upper Midwest Council, which allows comparison of functions and identification of relationships among trade centers.

This classification scheme was utilized in the preparation of Map 2, which identifies centers by availability of services or the extent of retail sales. The criteria used in the classification are presented next to the map for easy reference.

Service centers correspond to areas of population density. The "regional service centers" and the "community service centers," those possessing a great variety of services, are scattered along the iron range and on Lake Superior. The result of the service center concentration is that considerable land areas are great distances from even "partial convenience centers" (those with relatiely few services). Some of the more sophisticated services are greatly removed, in time as well as distance, from many locations in the region.

Housing

Like population, the housing services are clustered along the length of the iron range and near Duluth-Superior. The data shows variations in the composition of the vacancies, but in most cases the inhabitable vacancies are considerably less than the number of total vacancies; that is, there is a

substantial portion of the vacant housing which is not on the market or is substandard in terms of plumbing.

The summary conclusion is that the current housing supply in the Arrowhead region could not absorb any major population increase. Approximately half of the municipalities in the region cannot provide short-notice occupancy for significant increases in population.

Sewer and Water Facilities

The status and availability of sewer and water facilities are essential to an assessment of regional service capabilities since such facilities are primary adjuncts to housing and industrial development. It is useful to consider, as a proxy for facility status, the short-term capital improvement needs of the region for sewer and water. Those needs illustrate present service insufficiencies while providing a context for assessments of adequacy in terms of future development projections.

The geographical distribution of sewer and water facilities is shown in Map 5. Only municipalities with populations of 1,000 or more are included and all have facilities for both sewer and water. It should be noted that the map does not distinguish places by number of people or size of the area (except for the Western Lake Superior Sanitary District) serviced by the facilities.

Map 6 illustrates the short term water and sewer needs of each of these systems. Dollar requirements are proportional to the area of the semi-circles. The source data are presented in Table IV.

The source of information for municipalities with populations of less than 5,500 was the Areawide Comprehensive Plan for Water and Sewer prepared by the Arrowhead Regional Development Commission, 1972. For larger municipalities, information was obtained from the Municipal Needs List and Fiscal 1975 Project List of the Pollution Control Agency. Information regarding water needs was not

available for cities within the Western Lake Superior Sanitary District and the Areawide Planning Jurisdictions. It should be noted, therefore, that omissions from the tabulated data and from Map 6 reflect a lack of information rather than any lack of need.

The indicated "needs" are based upon computations utilizing criteria outlined in the source documents. It should be noted that although dollar requirements are indicative of major repair and construction needs, they can be somewhat deceptive. Throughout the region municipal water and sewer system improvements are required. In view of the region's need for municipal water and sewage system improvement and given the fact that many of the Minnesota Pollution Control Agency prioritized projects have been delayed due to funds impoundment, many municipalities would likely experience water and sewage problems if any additional residential and commercial development took place prior to the projects' completion date. In addition to municipal water and sewage problems, nearly 40 percent of the households in the region, largely rural, have on-site sewage systems or some other private system such as a privy or holding tank. Since the rural areas of the region--most of Aitkin and Koochiching Counties and the northern half of St. Louis, Lake and Cook Counties--have severe soil limitations for on-site sewage systems, a major health and environmental problem exists for the higher density rural portions of the region.

If municipal water and sewer systems cannot accommodate population increases, the alterntive will be on-site sewage systems. Such is an alternative that does not appear desirable unless major soil reclamation, special design or intensive maintenance can be required and provided.

The conclusion to be drawn is that municipal system improvements should precede any development and expansion which would stimulate local or regional population growth.

Health

The presented information is a key to the availability of health care services in the region but it would be inappropriate to use as a basis for evaluation of the quality of either health care or delivery systems in the region. It does, however, suggest areas of shortage. The state ratios of personnel or facilities per person are used as a standard for the assessment of possible medical service shortages. State ratios have been selected somewhat arbitrarily but should nonetheless offer an informative standard of comparison.

For health care facilities, the state ratio of general hospital beds per 1,000 is 5, and the ratio of nursing homes and boarding care homes is 10.6 and 2.7 respectively. The region exceeds the hospital bed ratio (6.3) but is below the state ratio for nursing homes (9) and boarding care homes (.5). On a county basis, Aitkin (3.3), Carlton (4.3), Cook (4.7) Itasca (4.4) and Lake (2.8) are all deficit counties for hospital beds. St. Louis County and specifically Duluth seem to account for the region's favorable ratio. Cook and Itasca are the only counties with a favorable nursing home bed ratio, and none of the counties has a favorable boarding care home ratio.

Cloquet, Duluth, Grand Rapids, Hibbing and Virginia are the only municipalities offering hospitals of size sufficient to be considered regional health facilities. Although the spatial distribution of hospitals appears to provide hospital services which are within reasonable proximity of population clusters, most of the facilities are relatively small. None of the region's hospital facilities are operating at full occupancy although hospitals in Aitkin, Koochiching and Lake Counties have relatively high occupancy rates. It should be recognized, however, that occupancy rates may be misleading since small hospitals with low occupancy rates have very few vacant beds.

In terms of the spatial distribution of health care personnel and facilities

vis-a-vis copper-nickel development, the major problem area may be a shortage of personnel in the areas surrounding the initial development, e.g., Ely, Hoyt Lakes, Aurora and Babbitt. Also any major population increase would probably require hospital facility expansion. These shortages may be more acute than the figures suggest since mining represents more occupational health hazards than most other professions.

The state ratios for major health manpower categories per 100,000 persons are the following: primary care physicians--41.5, secondary physicians--22.6, and dentists--49.5. Ratios of the Arrowhead Region exceed these in all respects: primary care physicians--43.5, secondary care physicans--44.6, and dentists--55.5. However, Aitkin (26.3), Koochiching (40.9) and Lake (37.5) fall below the state average for primary care physicians. Secondary care physician ratios show Aitkin (0), Carlton (14.3), Itasca (16.9), Koochiching (0), and Lake (7.5) well below the state average. Dentist ratios also fall short of the state average in Aitkin (17.5), Itasca (42.2), and Lake (37.5).

Compared to state ratios, the county ratios suggest that Aitkin, Itasca, Koochiching, and Lake Counties have significant health manpower shortages. An examination of St. Louis County by municipality proves valuable since a high concentration of health personnel in Duluth most likely biases county data. Duluth, Hibbing, and Virginia are the major health manpower centers in St. Louis County and the region. Aurora, Ely and Eveleth would be secondary health manpower centers in St. Louis, but in absolute numbers of personnel they do not approach the major centers. Since these six municipalities account for most of the health manpower in St. Louis County, it follows that the other municipalities are relatively sparsely populated with health personnel. Inspection of disaggregated data from other counties would likely reveal that health care centralization occurs in all counties as well as in the region as a whole.

By reason of the large rural component in the regional population (42.6%), the nature of transportation network, and observed health manpower clustering, the region may experience serious problems in accessibility to health personnel despite the generally favorable personnel ratios. At the very least, it would appear that emergency medical services may be difficult to deliver. Furthermore, many households in the region are likely constrained to plan carefully for their physician and dentist visits; such would seem to be an obstacle to regular and preventive treatment.

Education

In the area where the initial impact of copper-nickel mining will be greatest, the shortage of classroom space is not very acute. In Aurora for example, the elementary schools can accommodate 600-700 more students and the secondary school can handle 500 more. Present transportation is also sufficient to handle these 1,200 additional students. Aurora (1,500), Babbitt (300), Biwabik (325), Ely (300) school districts, where the greatest initial mining impact would be, could handle a maximum of 2,425 additional students--an increase of 34% over the present enrollment.

Student-teacher ratios are favorable throughout the Arrowhead region. The Proctor district is the highest with 22 students per teacher and the lowest is 12.4 students per teacher in the South Koochiching-Rainy River district. The overall student-teacher ratio for the region is 17.8. If the enrollment were to increase to its capacity of an additional 15,299 students, the student-teacher ratio, with the present number of teachers, would be 21.1. To maintain the present ratio of 17.8, the region would require an additional 868 teachers.

Energy

The Arrowhead region is dependent upon fossil fuels for energy production. If shortages persist, a limit will be placed on the region's growth potential. Yet even if fuels are available, new generating facilities, transmission lines and pipelines will probably be required to accommodate a major copper-nickel development. In view of fossil fuel dependence and forecasted shortages, it would also not be surprising if the region followed state and national trends and proposed nuclear facilities to accommodate heavy increases in energy requirements.

Transportation

Map 16 shows airline servicing of the region. Data indicates that in general the Arrowhead Region is characterized by a transportation system designed and operated to move goods and people along the iron range and from there to and from Duluth, the major regional center. The transportation systems servicing the area of prime copper-nickel mineralization are privately held or of very small capacity. Copper-Nickel development there would necessitate some substantial investments in transportation systems.

Recreation

Governmentally owned or administered lands present two separate issues for assessment: 1) the provision of recreation as a service to local and other populations, and 2) the potential conflicts in land uses between recreation and development.

Data reveals that much of the land area in the region is governmentally controlled and provides substantial recreational amenity for present and projected regional populations. Potential land use conflicts would seem to exist, however, between present recreational uses and most of the developmental uses proposed for the prime copper-nickel area.

FINDINGS: ALTERNATIVE COPPER-NICKEL DEVELOPMENT AND GROWTH PATTERNS

Because no copper-nickel development proposal with engineering specifications has been completed, eleven possible development conditions or schemes have been examined. These alternate developments use different assumptions regarding growth rates and degrees of development regulation. Degrees of regulation are expressed in terms which apply mainly to copper-nickel mining activity. The four types of regulation are defined as follows:

Moratorium: This assumes that no copper-nickel development takes place, either because development is uneconomical or frustrated by governmental regulation.

Rate, Location, Scale: This assumes somewhat less regulation than a complete moratorium. The rate of development, or the location (such as preclusion of mining north of the Laurentian Divide) or scale of mining operations is here assumed to be restricted by governmental action. In the known growth situation, this regulation is tantamount to moratorium.

Type Regulation: Such represents the case where a certain type of mining activity, particularly smelting, is not allowed in the region. It is assumed that elimination of smelting would effectvely half the employment of any given mining development.

Market Model: The case of no regulation; market forces operate so that mining activity occurs in the region as suggested by proposals made by INCO and other potential copper-nickel producers.

	EMPLOYEES	YEARS	NUMBER OF PROJECTS
INCO:	800	1978 and after	1
	375*	1976-7	
AMAX:	800	1981 and after	1
	375*	1978-9	
Other possible developments	1000	1985 and after	2
	750*	1983-4	
increasingly uncertain ↓	800	1987 and after	1
	375*	1985-6	
	5000	1990 and after	3
	1125*	1988-9	

*Construction employees, not permanent employees--jobs terminate after two years.

For each alternative regulation assumption, estimates as to the desired number of primary export workers in mining were determined from projected employment data found in newspaper reports. INCO data suggested that a proposed copper-nickel development would require 800 employees. It was assumed that subsequent developments would have the same employee requirements. Preceding each development by two years would be a labor requirement of 375 construction personnel. Such jobs would last only two years. As regulations are imposed, these values are reduced and delayed and the more speculative developments are eliminated. Thus, type regulation reduces the construction and mining worker requirements by one-half, and "rate, location, and scale" regulation further reduces and delays labor additions.

For each growth philosophy, the workers in the export part of retreation were assumed to grow at different rates. The rate was denoted by a "recreation growth factor" and assigned values of 1%, 3% and 6% per year for the known, moderate and rapid growth philosophies respectively. The original number of workers in 1970 was 4441.

The following pages show the simulated regional responses to each of the alternate development schemes depicted in Table 1. Results are presented on a uniform format which includes the development assumptions, regional economic and demographic projections, projected state and local direct and indirect revenues, and a service facility assessment.

TABLE 1 ALTERNATIVE COPPER NICKEL DEVELOPMENT AND GROWTH PATTERNS

GROWTH RATE	REGULATORY POLICY			
	MINING MORATORIUM	RATE, SCALE AND LOCATION REGULATION	"TYPE" REGULATION	"MARKET MODEL"
KNOWN GROWTH	Run 1 (Known Growth-Moratorium) (Basic Run)	---- (Known Growth - Rate, Scale and Location Reg.) (Same as Run 1)	Run 2 (Known Growth-Type Reg.)	Run 3 (Known Growth-Market Model)
MODERATE GROWTH	Run 4 (Moderate Growth Moratorium)	Run 5 (Moderate Growth-Rate, Scale and Location Reg.)	Run 6 (Moderate Growth-Type Regulation)	Run 7 (Moderate Growth-Market Model)
RAPID GROWTH	Run 8 (Rapid Growth-Moratorium)	Run 9 (Rapid Growth-Rate, Scale and Location Reg.)	Run 10 (Rapid Growth-Type Regulation)	Run 11 (Rapid Growth-Market Model)

INCREASING GROWTH ↓

(Decreasing Regulation) →

KNOWN GROWTH MORATORIUM (Run 1)

Assumptions:

"Model" copper-nickel mining developments:	None
Smelting in Minnesota:	No
Taconite mining developments:	None
Public administration developments:	None
Annual recreation industry growth:	1%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	111,500	111,000	110,500
Unemployment	4.4%	4.0%	3.8%
Population	312,000	308,000	304,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	----	----
AMAX-prototype mine	----	----	----
other mine developments:			
all on federal land	----	----	----
all on state land	----	----	----
all on private land	----	----	----
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	----	----	----
Moderate revenue growth	----	----	----
Steady-state revenue level	----	----	----
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	A	A
Transportation	A	A	A
Recreation	S	S	S

KNOWN GROWTH-TYPE REGULATION (Run 2)

Assumptions:

"Model" copper-nickel mining developments:	1983 (INCO)
Smelting in Minnesota:	No
Taconite mining developments:	None
Public administration developments:	None
Annual recreation industry growth:	1%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	111,500	111,000	111,000
Unemployment	4.4%	4.0%	3.8%
Population	312,000	308,000	304,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	$581,000	$581,000
AMAX-prototype mine	----	----	----
other mine developments:			
all on federal land	----	----	----
all on state land	----	----	----
all on private land	----	----	----
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	----	----	----
Moderate revenue growth	----	----	----
Steady-state revenue level	----	----	----
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	A	A
Transportation	A	A	A
Recreation	S	S	S

KNOWN GROWTH-MARKET MODEL (Run 3)

Assumptions:

"Model" copper-nickel mining developments:	1978 (INCO)
Smelting in Minnesota:	Yes
Taconite mining developments:	None
Public administration developments:	None
Annual recreation industry growth:	1%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	112,500	112,500	112,500
Unemployment	4.0%	3.8%	3.6%
Population	314,000	310,000	308,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	$806,000	$806,000	$806,000
AMAX-prototype mine	----	----	----
other mine developments:			
all on federal land	----	----	----
all on state land	----	----	----
all on private land	----	----	----
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$3,560,000	$4,460,000	$11,400,000
Moderate revenue growth	3,160,000	3,560,000	7,680,000
Steady-state revenue level	2,340,000	2,340,000	4,680,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	A	A
Transportation	A	A	A
Recreation	S	S	S

MODERATE GROWTH-MORATORIUM (Run 4)

Assumptions:

"Model" copper-nickel mining developments: None

Smelting in Minnesota: No
Taconite mining developments: 1985, 1990 (800 jobs each development)
Public administration developments: 1980, 1985, 1990 (400 jobs each)
Annual recreation industry growth: 3%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	113,500	114,500	117,500
Unemployment	3.9%	3.2%	3.9%
Population	320,000	320,000	326,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	----	----
AMAX-prototype mine	----	----	----
other mine developments:			
all on federal land	----	----	----
all on state land	----	----	----
all on private land	----	----	----
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$14,240,000	$26,760,000	$62,700,000
Moderate revenue growth	12,640,000	21,360,000	42,240,000
Steady-state revenue level	9,360,000	14,040,000	25,740,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	A	A
Transportation	A	A	A
Recreation	S	S	S

MODERATE GROWTH-RATE, SCALE, LOCATION (Run 5)

Assumptions:

"Model" copper-nickel mining developments:	1981 (AMAX), 1988 (2 other)
Smelting in Minnesota:	Yes
Taconite mining developments:	1985, 1990
Public administration developments:	None
Annual recreation industry growth:	3%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	113,500	115,000	120,000
Unemployment	3.8%	3.6%	4.0%
Population	320,000	320,000	335,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	----	----
AMAX-prototype mine	----	$8,696,000	$ 9,726,000
other mine developments:			
all on federal land	----	----	$ 1,712,000
all on state land	----	----	$19,452,000
all on private land	----	----	$ 1,724,000
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$14,240,000	$26,760,000	$88,350,000
Moderate revenue growth	12,640,000	21,360,000	59,520,000
Steady-state revenue level	9,360,000	14,040,000	36,270,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	A	A
Transportation	A	A	A
Recreation	S	S	S

MODERATE GROWTH-TYPE REGULATION (Run 6)

Assumptions:

"Model" copper-nickel mining developments: 1983 (INCO), 1986 (AMAX)

Smelting in Minnesota:	No
Taconite mining developments:	1985, 1990
Public administration developments:	None
Annual recreation industry growth:	3%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	113,500	114,500	117,500
Unemployment	3.9%	3.3%	4.0%
Population	320,000	320,000	328,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	$581,000	$ 581,000
AMAX-prototype mine	----	----	$ 9,501,000
other mine developments:	----	----	----
all on federal land	----	----	----
all on state land	----	----	----
all on private land	----	----	----
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$14,240,000	$26,760,000	$68,400,000
Moderate revenue growth	12,640,000	21,360,000	46,080,000
Steady-state revenue level	9,360,000	14,040,000	28,080,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	A	X
Transportation	A	A	X
Recreation	S	S	S

MODERATE GROWTH-MARKET MODEL (Run 7)

Assumptions:

"Model" copper-nickel mining developments: 1978 (INCO), 1981 (AMAX), 1985 (1 other

Smelting in Minnesota:	Yes
Taconite mining developments:	1985, 1990
Public administration developments:	None
Annual recreation industry growth:	3%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	114,500	117,500	121,000
Unemployment	3.7%	3.8%	4.0%
Population	320,000	322,000	336,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	$581,000	$ 581,000	$ 581,000
AMAX-prototype mine	----	8,471,000	9,501,000
other mine developments:			
all on federal land	----	581,000	581,000
all on state land	----	8,471,000	9,501,000
all on private land		637,000	637,000
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$14,240,000	$31,220,000	$91,200,000
Moderate revenue growth	12,640,000	24,920,000	61,440,000
Steady-state revenue level	9,360,000	16,380,000	37,440,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	A
Sewer and Water	A	A	A
Health care	A	A	A
Education	S	S	S
Energy	A	X	X
Transportation	A	X	X
Recreation	S	S	S

RAPID GROWTH - MORATORIUM (Run 8)

Assumptions:

"Model" copper-nickel mining developments: None

Smelting in Minnesota: No
Taconite mining developments: 1985, 2 in 1990 (800 jobs for each)
Public administration developments: 1980, 1985, 1990 (600 new jobs each)
Annual recreation industry growth: 6%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	115,500	121,500	131,000
Unemployment	3.7%	3.8%	3.7%
Population	324,000	338,000	365,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	----	----
AMAX-prototype mine	----	----	----
other mine developments:			
all on federal land	----	----	----
all on state land	----	----	----
all on private land	----	----	----
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$21,360,000	$66,900,000	$173,850,000
Moderate revenue growth	18,960,000	53,400,000	117,120,000
Steady-state revenue level	14,040,000	35,100,000	71,370,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	X
Sewer and Water	A	A	X
Health care	A	A	X
Education	S	A	A
Energy	A	A	X
Transportation	A	A	X
Recreation	S	S	S

RAPID GROWTH-RATE, SCALE, LOCATION (Run 9)

Assumptions:

"Model" copper-nickel mining developments: 1981 (AMAX), 1988 (2 other)

Smelting in Minnesota:	Yes
Taconite mining developments:	1985, 2 in 1990 (800 new jobs each)
Public administration developments:	None
Annual recreation industry growth:	6%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	116,000	121,500	132,500
Unemployment	3.6%	3.9%	3.7%
Population	324,000	336,000	366,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	----	----
AMAX-prototype mine	----	$8,696,000	$9,726,000
other mine developments:			
all on federal land	----	----	$1,612,000
all on state land	----	----	$19,452,000
all on private land	----	----	$1,724,000
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$21,360,000	$62,440,000	$176,700,000
Moderate revenue growth	18,960,000	49,840,000	119,040,000
Steady-state revenue level	14,040,000	32,760,000	72,540,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	X
Sewer and Water	A	A	X
Health care	A	A	X
Education	S	A	X
Energy	A	A	X
Transportation	A	A	X
Recreation	S	S	S

RAPID GROWTH-TYPE REGULATION (Run 10)

Assumptions:

"Model" copper-nickel mining developments: 1983 (INCO), 1986 (AMAX), 1990 (1 othe

Smelting in Minnesota: No
Taconite mining developments: 1985, 2 in 1990 (800 new jobs for each
Public administration developments: None
Annual recreation industry growth: 6%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	115,500	121,000	132,000
Unemployment	3.7%	3.9%	3.7%
Population	324,000	336,000	360,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	----	$581,000	$ 581,000
AMAX-prototype mine	----	----	$9,501,000
other mine developments:			
all on federal land	----	----	$ 581,000
all on state land	----	----	$9,501,000
all on private land	----	----	$ 637,000
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$21,360,000	$62,440,000	$159,600,000
Moderate revenue growth	18,960,000	49,840,000	107,520,000
Steady-state revenue level	14,040,000	32,760,000	65,520,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	X
Sewer and Water	A	A	X
Health care	A	A	X
Education	S	S	A
Energy	A	A	X
Transportation	A	A	X
Recreation	S	S	S

RAPID GROWTH-MARKET MODEL (Run 11)

Assumptions:

"Model" copper-nickel mining developments:	1978 (INCO), 1981 (AMAX), 1985 (other) 1987 (other), 1990 (other)
Smelting in Minnesota:	Yes
Taconite mining developments:	1985, 2 in 1990 (800 new jobs for each
Public administration developments:	None
Annual recreation industry growth:	6%

Year	1980	1985	1990
Part A: Regional Demographic-Economic Projections			
Employment	117,000	124,000	135,000
Unemployment	3.8%	3.9%	3.6%
Population	330,000	346,000	374,000
Part B: Projections for State and Local Government Revenue (1975 = $1.00)			
(1) Direct Revenues attributable to:			
INCO-prototype mine	$ 806,000	$ 806,000	$ 806,000
AMAX-prototype mine	----	$8,696,000	$9,726,000
other mine developments:			
all on federal land	----	$ 806,000	$2,418,000
all on state land	----	$8,696,000	$29,178,000
all on private land	----	$ 862,000	$2,586,000
(2) Indirect Revenues due to export industry expansion:			
Rapid revenue growth	$32,040,000	$84,740,000	$199,500,000
Moderate revenue growth	28,440,000	67,640,000	134,400,000
Steady-state revenue level	21,060,000	44,460,000	81,900,000
Part C: Service Facility Assessment (see footnote 1)			
Housing	A	A	X
Sewer and Water	A	A	X
Health care	A	A	X
Education	S	A	X
Energy	A	X	X
Transportation	A	X	X
Recreation	S	S	S

FOOTNOTE 1: SERVICE ASSESSMENT DECISION RULES

SERVICE	1975 STATUS	DIRECT IMPACTS (SERVICE DEMANDS DUE TO INDUSTRY NEEDS)	INDIRECT IMPACTS (SERVICE DEMANDS DUE TO POPULATION NEEDS)
Housing	Small Need	(No direct impact)	A = population growth between -2% and 5% in 5 year period. S = over 2% decline in 5 years. X = over 5% growth in 5 years.
Sewer and Water	Moderate Need	X = over 4 mining developments in 5 years	A = population growth between -2% and 5% in 5 years. S = over 2% decline in 5 years or X = 5% growth in 5 years
Health Care	Small Need; distribution problem	(No direct impact)	(Same as Housing)
Education	Surplus of 17% Capacity	(No direct impact)	1980: A=10-15% S=less than 10% X=more than 15% growth of child and teen population in 5 years. 1985: A=5-10% S=less than 5% X=more than 10% growth of same in 5 years 1990: A=2-7% S=less than 2% X=more than 7% growth of same in 5 years
Energy	Sufficient, but oil dependent	A=(up to 2 mining developments in 5 yrs) and(-2% to 5% growth in population in 5 years) S=(no mining developments) and(over 2% decline in 5 years) X=(3 or more mining developments in 5 yrs.) or (over 5% increase in 5 years)	
Transportation	Sufficient	(Same as Energy)	
Recreation	Large surplus	S for all cases, since no need foreseen	