Volume 5-Chapter 15

REGIONAL ECONOMIC IMPACTS OF COPPER-NICKEL DEVELOPMENT

Minnesota Environmental Quality Board
Regional Copper-Nickel Study
*Authors: Mark Donaldson
Pat Meagher
Wilbur Maki

*Please contact Royden E. Tull regarding questions or comments on this chapter of the report.

REGIONAL COPPER-NICKEL STUDY REPORT OUTLINE

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 2½ 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)

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Volume 5-Chapter 15 REGIONAL ECONOMIC IMPACTS OF COPPER-NICKEL DEVELOPMENT

15.1 INTRODUCTION AND SUMMARY OF FINDINGS

Copper-nickel development will make significant contributions to the economy of the Study Area and the Arrowhead region (Minnesota Development Region III plus Douglas County, Wisconsin). A copper-nickel operation will generate direct impacts in terms of employment, payroll, operating expenditures, and capital investment, and many indirect impacts will "spill over" to the economy as a whole. The direct impacts of copper-nickel development will be "multiplied" many times over in certain sectors of the economy.

The economy of the Study Area is already dominated by the mineral industry with about one-third of all employment concentrated on the taconite industry. However, over the next twenty years, the dominance of the taconite industry is expected to diminish to about 22 percent of all Study Area employment if the productivity of the taconite industry increases and if the region follows the nationwide trend toward a more service oriented economy. The open pit copper-nickel development model would result in concomitant service industry growth so that the overall mineral industry employment with a single fully integrated copper-nickel operation would still represent only about 23 percent of all employment in the year 2000. However, total employment would increase from 24,215 in the baseline to 31,867 in the open pit scenario. Study Area baseline employment (without copper-nickel development) is expected to peak about 1985, resulting in a corresponding population peak at about the same time, and decrease to 1970 levels by the year 2000, due to projected labor productivity increases, particularly in the taconite industry. Despite a downturn in employment projections for the last fifth of the twentieth century, Study Area baseline gross output is expected to show steady growth and baseline earnings will remain relatively stable.

The projected downturn in Study Area employment could be effectively negated and steady growth realized with carefully timed sequencing of copper-nickel operational start-up dates. A single fully integrated copper-nickel operation would employ about 2,300 employees with an annual payroll of about $46.3 million, an average annual salary of about $20,200 ($1977).

The operation would contribute about $282 million ($1970) to Study Area gross output each year and $33.6 ($1970) million to annual Study Area earnings.

The indirect impacts of copper-nickel development, changes resulting in the economy as a whole from initial copper-nickel economic activity, are in some cases expected to be greater than the direct impacts themselves. Indirect employment resulting from a single copper-nickel operation is projected to reach from 7,000 to 9,100 by 1995, ten years after production begins. This is from 3.3 to 3.5 indirect jobs for every copper-nickel job. Indirect gross output is projected to increase by $137 to $175 million annually ($1970) by 1995; or $.48 to $.61 for every dollar of copper-nickel gross output. And indirect earnings are projected to increase by $56 to $71 million annually ($1970) by 1995; 1.9 times the direct earnings resulting from copper-nickel development.

Despite the very significant gains in Study Area employment, output and earnings resulting from copper-nickel development there remains some question as to the real net benefit to the region in terms of per capita or per employee economic indicators. As projected by SIMLAB the gross output per employee of the baseline economy (without copper-nickel) is expected to increase from $30,228 in 1987 to $46,195 in the year 2000 ($1970). With copper-nickel development, gross output per employee is projected to reach \$47,975 (\$1970) by the year 2000, a 4 percent increase over baseline conditions. In intermediate years, development gross output/employee reaches 11 percent above projected baseline levels.

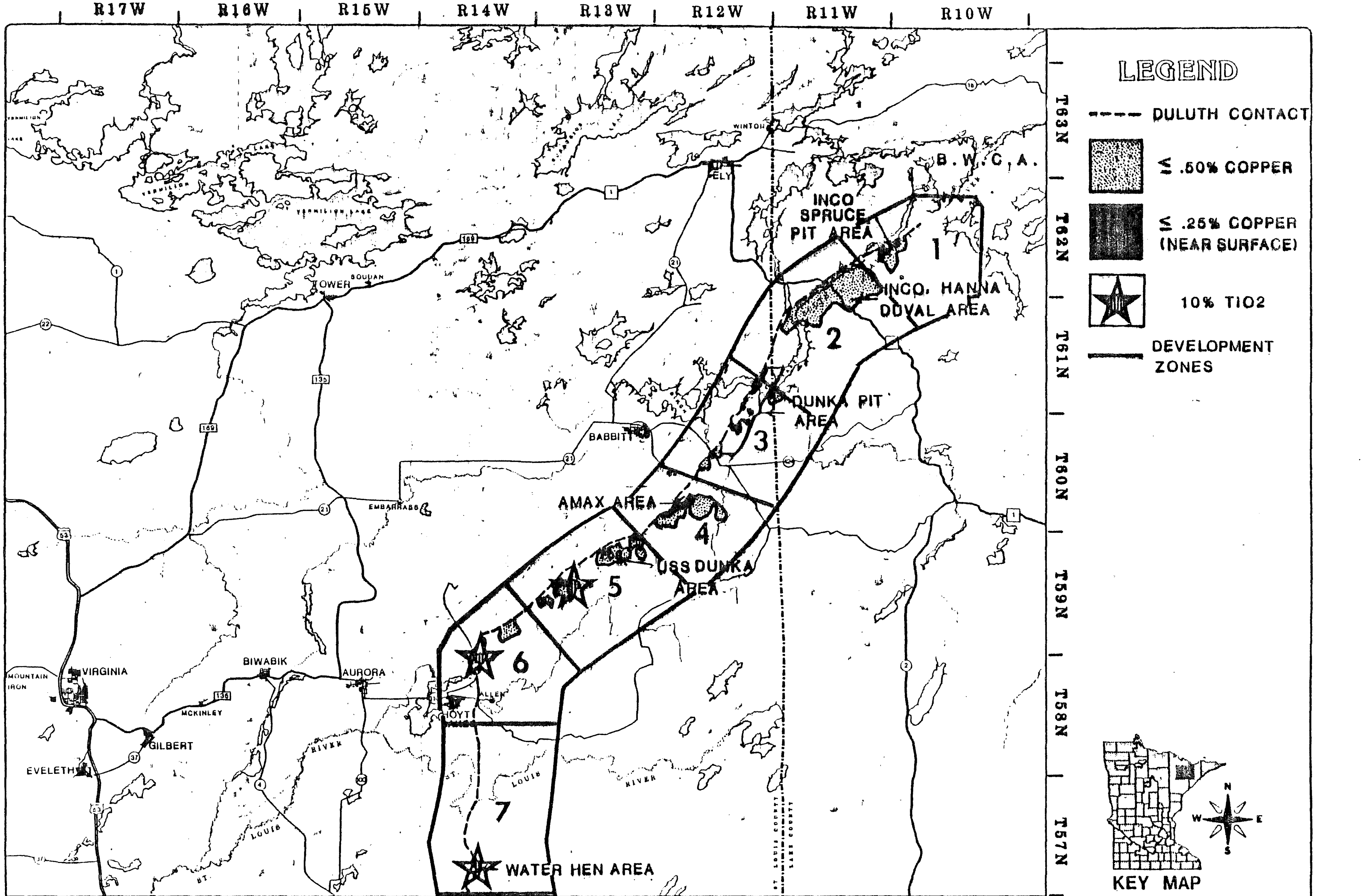
However, projected development earnings/employee figures are below those of the baseline conditions. Study Area baseline earnings per employee is estimated to increase from \$10,311 in 1987 to \$13,296 by the year 2000 (\$1970). Meanwhile, earnings per employee for the copper-nickel open pit scenario are projected to reach \$12,699 (\$1970) by the year 2000, 4 percent below baseline conditions.

15.2 STUDY AREA

Known copper-nickel resources exist in Lake and St. Louis counties in northeastern Minnesota. These resources occur approximately along a line extending from a point near Ely southwestward to a point a few miles south of Hoyt Lakes (see Figure 1). The Study Area (see Figure 2) includes a small segment of Lake County but most economic effects from development in Lake County would manifest themselves in St. Louis County, because few people or business firms located in the Lake County portion of the Study Area would be affected. Existing township boundaries define the Study Area within St. Louis County in order to facilitate data collection.

Figure 1, 2

At present, there is no mining of northeastern Minnesota copper-nickel resources. Significant quantities of resources have been located as a result of drilling and other exploratory work (Volume 3-Chapter 2). Available information on the location and magnitude of the copper-nickel resources is summarized in Table 1 (which is keyed to Figure 1). In Figure 1, the areas in which the resources



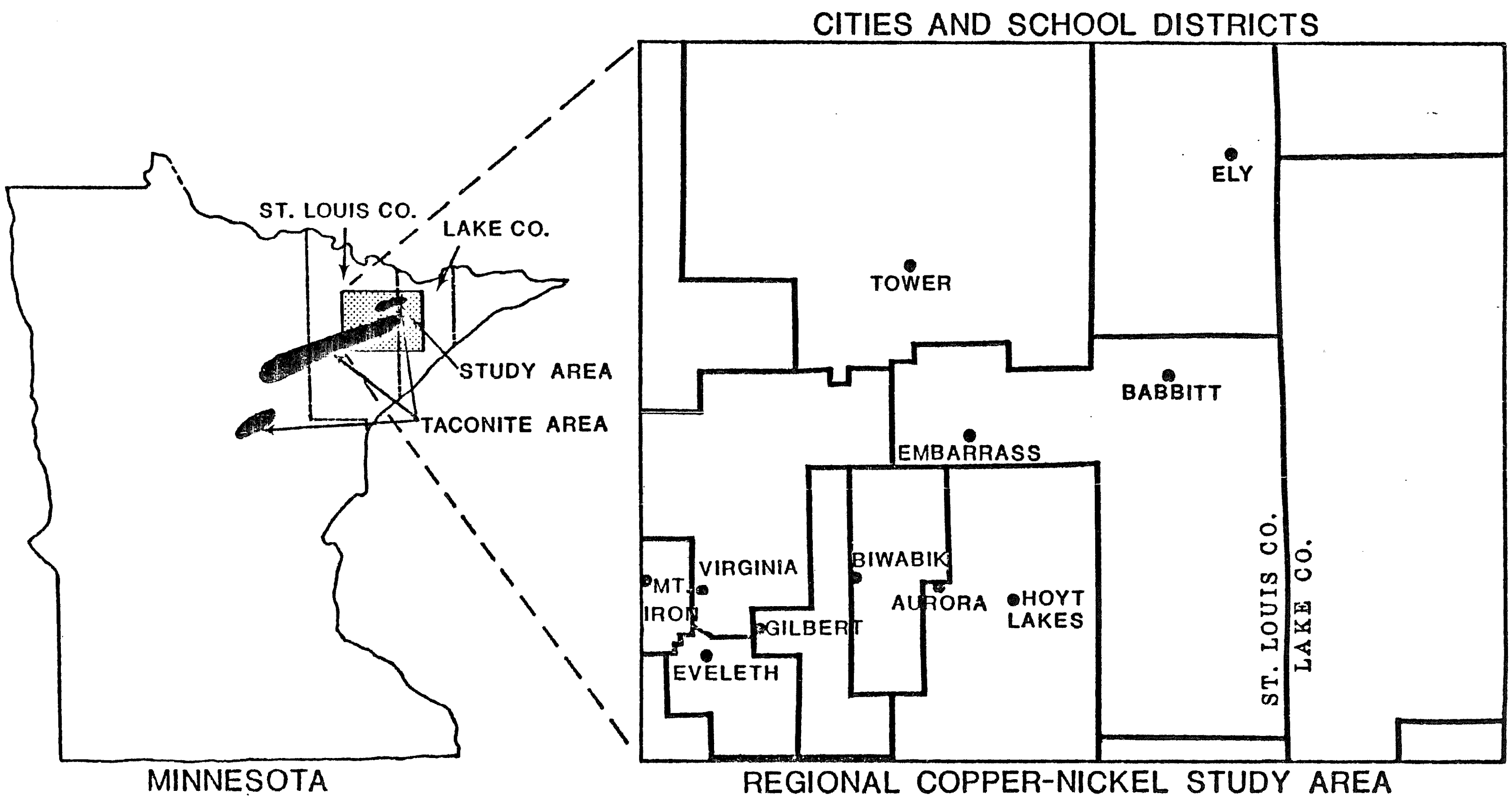
MEQB REGIONAL COPPER-NICKEL STUDY

FIGURE 1

MINERALIZATION LOCATION MAP

FIGURE 2

STATE AND LOCAL UNITS OF GOVERNMENT



occur are numbered and relevant statistical information is presented by numbered area in Table 1. All data in Table 1 are in terms of copper content because it is the most abundant non-ferrous metal resource in the area. The quantity of estimated nickel resource can be determined by dividing the copper values given in the table by 3.33 (see Volume 3-Chapter 2, section 2.1.2 for additional detail).

Table 1

Mining of iron ores, primarily taconite, is and has been, underway within the Study Area for many years. So, although copper-nickel mining would be new to the area, it would be in addition to the extensive mining operations already being conducted there. An evaluation of the economic significance of additional mining activity is the overall objective of this chapter.

15.3 REGIONAL ECONOMIC CHARACTERISTICS

The industrial composition of the Study Area from 1950 to 1970 was characterized by a very slight diversification with a declining importance in mining and an employment increase in wholesale-retail services and professional services. Other industrial sectors (construction, manufacturing, public administration, transportation) also showed changes during this time. These changes were, however, inconsistent or unspectacular. Despite this diversification, mining remains the predominant employer in most of the communities.

The economies of communities with little commercial activity and restricted service functions also tend to be those most dominated by mining. The cities of Hoyt Lakes (developed by Erie Mining Company) and Babbitt (developed by Reserve Mining Company) were created in the mid-fifties to house and provide services for

Table 1. Copper ore tonnages by zone (in millions of metric tons).

RESOURCE ZONE	.25 to .5 PERCENT COPPER (near surface)	.5 PERCENT COPPER (less than 1000 ft from surface)	.5 PERCENT COPPER (more than 100 ft from surface)
1	107.2	369.9	371.9
2	--	339.6	--
2&3*	14.6	112.5	--
3	245.8	18.9	76.1
4	183.4	49.1	545.2
5	38.1	73.4	232.8
6	59.6	52.0	48.9
7	--	11.2	--
TOTAL	647.7	1026.8	2889.6
Average Copper Grade (percent)	0.34	0.66	0.66

*Zones 2 and 3 copper resource under Birch Lake.

the respective mining company's employees. They were "new towns" in every sense of the phrase and remain closely tied to the single mining company for their existence, although the companies now claim a "hands off" policy in community affairs.

Other communities (e.g. Virginia, Eveleth, and, to some extent, Ely) draw on several other categories of employment for their economic base. Mining, then, comprises a proportionately smaller segment of the total labor force. It remains apparent, however, that much of this diversified employment which competes with mining in importance is dependent upon the basic resource extraction industrial activity.

Employment in professional services (e.g. doctors, dentists, lawyers) changed from a total of 1,366 persons in 1950 to almost 2,300 by 1970 (an increase of about 68 percent), although the total population increased by only 22 percent. These data suggest that the Study Area is moving toward a higher level of self-sufficiency than it has had in the past, especially in health care. Traditional reliance, therefore, on Duluth or the Twin Cities for some professional services may weaken as the quality and availability of professional services increase.

15.3.1 <u>Base Industries</u>

It is often said that the Arrowhead Region's economy depends upon the three Ts--Taconite, Timber, and Tourism--with Transportation as a weaker fourth. Timber and tourism are less significant and more difficult to document than the taconite mining industry.

15.3.1.1 <u>Mining</u>--The economy of the Study Area is dominated by the iron ore and taconite industry. Each community within the Study Area is or was at one time very heavily dependent upon taconite or iron ore in terms of employment, tax base, and cash flow. The taconite industry is currently undergoing a tremendous expansion program that will add about 4,000 permanent jobs. This expansion will also provide for an additional 8,000 construction jobs during the duration of expansion (expected to end by 1980) as well as an additional $1.5 billion in capital investment and it will expand capacity by about 75 percent of 1975 production levels. By 1984, some 16,000 people will be employed by taconite and iron companies and will carry home and distribute throughout the region a total annual payroll of $201 million ($1970). Total capital investment will reach nearly $2.5 billion, and capacity will reach 71 million tons of iron ore and taconite annually (MDED 1976). Taconite reserves are estimated to last more than 100 years at present production rates (Nelson, et.al. 1979).

15.3.1.2 Timber--The timber resources in northeastern Minnesota are obvious to anyone traveling through the region. Forested lands cover 10.36 million of the 13.02 million acres (79.5 percent) in the Arrowhead Region. St. Louis County itself has a ratio of 82 percent of total acres forested--3.5 million of 4.29 million acres (MDNR 1975). Employment in the forestry sector, however, remains relatively low in St. Louis County. Approximately 800 employees in the forestry sector in 1972 made up a mere 1.5 percent of total employment in St. Louis County. Other Arrowhead counties are more dependent on forestry--Koochiching (39 percent of total employment), Carlton (32 percent), and Itasca (19 percent) (ARDC 1975).

According to the U.S. Department of Agriculture, pulpwood accounts for about 90 percent of the total estimated value of forest products harvested in Minnesota (MDED 1976). The estimated value of pulpwood produced in St. Louis County in 1972 was nearly $120 million, and St. Louis County contributed about one-third of the Arrowhead Region's pulpwood production: 305,000 of 920,000 cords. This production totaled 23 percent of the state's total pulpwood production (ARDC 1975).

An annual payroll of about $1.2 million to the 800 employees gives some insight into the nature of the timber industry in St. Louis County (MDED 1976). The seasonal and part-time nature of the employment pattern is reflected in the $1,500 average annual salary for timber products employees in St. Louis County. Certainly, a full range of employment opportunities exist--from the capital--intensive, high-paying mill work to the part-time forester who owns only a chain saw and a tractor, but the average annual salary reflects the influence of the part-time forester.

The timber sector could be characterized as one possessing potential. The resource exists in great numbers, it is renewable, and at present the sector seems to be operating below its capacity.

15.3.1.3 Tourism--With the North Shore of Lake Superior, the Boundary Waters Canoe Area (BWCA), and the newly created Voyageurs National Park, the Arrowhead Region offers a recreation package unmatched by many areas in the country. In 1970 there were more than 650 resorts providing services throughout the region to vacationers. In St. Louis County alone, there were more than 5,500 second homes used on a seasonal basis. The ARDC reports that each second home contributes $1,800 to the local economy each year (ARDC 1975). At this rate, the second-home owners in St. Louis County contribute nearly $10 million annually. Results of a Regional Copper-Nickel Study survey indicate that about $2,050 per seasonal household were spent in the Ely area during the 1977 calendar year (Volume 5-Chapter 16).

Determining total economic contribution of tourism and recreation is exceedingly difficult. Several studies have arrived at economic contributions of tourism in specific areas, but none have dealt with the Study Area as a whole. A figure of $139 million was attributed to the economic expenditures of tourists in the Arrowhead Region as a whole in 1975 (MDED 1976).

A primary difficulty in assessing tourism's impact on an economy is defining the tourism sector itself. The hospitality services which are utilized by travelers are intertwined with the local economy to such a degree that it is nearly impossible to separate the dollars spent by tourists from those spent by local residents. These hospitality services--such as the gas stations, drug stores, grocery stores--make up a sizable portion of the economic contribution of tourism as a whole. Without primary data gathering and surveying, the true economic contributions of tourism can only be approximated.

A study of the economic structure of Ely, Minnesota, found that the economic contribution of tourism to that part of the Study Area was very significant (Volume 5-Chapter 16). In this study, the dollars spent by tourists were separated from the dollars spent by residents through primary data gathering. In addition, the employment resulting from tourism was calculated.

Analysis of the data provides estimates:

...that total 1976 sales for the 284 Ely area firms was about $58 million, with about $31 million in the form of exports from the locale. Tourism represented almost $6 million in sales, or about 20 percent of total export sales. Of the estimated Ely area employment of about 1,600 persons, approximately 21 percent are employed as a result of tourism, with another 371 employees indirectly supported by initial tourist expenditures. The above estimates pertaining to tourism may be low because 1976 was an atypical year for this industry. The severe drought and resulting fire hazard in northeastern Minnesota significantly limited recreational activities and access within the Superior National Forest and the BWCA (Volume 5-Chapter 16).

These figures pertaining to the Ely area would not be directly applicable to the rest of the Study Area but do indicate a range of potential economic contributions by the tourism industry to the Study Area.

15.3.1.4 <u>Summary</u>--The economy of northeastern Minnesota in general and the Study Area specifically can be characterized as one which is dominated by a single industry, mining. Mining serves as catalyst for induced and indirect economic activity as well as providing a tremendous direct economic base for the area.

Aside from taconite mining, the region is blessed with forests, lakes, and rivers which provide economic as well as aesthetic benefits to the area. While considerably smaller than the economics of mining, the economic contributions of timber and tourism are significant.

15.3.2 Personal Income

Average gross incomes in the Arrowhead Region rank somewhat below the state average gross income per individual tax filer (Table 2). Within the Region, Aitkin County had the lowest average gross income in 1970 and 1974, while Lake County had the highest average gross income during the same period (Minnesota Department of Revenue 1970 and 1974).

<u>Table 2</u>

St. Louis County ranked just below the state gross income level, considerably behind Washington County (the state's highest 1974 average), and comfortably ahead of Clearwater County (the state's 1974 low average) in 1974. Twenty-one counties had average gross incomes greater than St. Louis County; 65 counties had lower average gross incomes.

Table 2. Minnesota gross income per filer.

	1974 AVERAGE GROSS INCOME	% OF STATE AVERAGE	1974 AVERAGE GROSS INCOME	% OF STATE AVERAGE	% CHANGE IN GROSS INCOME
Arrowhead Counties	$6,093	94	$7,614	94	+25
St. Louis	6,246	96	7,853	97	+26
Lake	6,330	98	8,087	100.2	+28
Cook	4,861	75	6,311	78	+30
Aitkin	4,303	66	5,383	67	+25
Koochiching	6,058	93	7,312	91	+21
Itasca	5,851	90	7,251	90	+24
Carlton	5,901	91	7,197	89	+22
Metro Area					
Washington County (highest in state)	7,467	115	9,508	118	+27
Region Two					
Clearwater (lowest in state)	4,043	62	5,217	65	+29
State	6,485	100	8,067	100	+24

SOURCE: Minnesota Department of Revenue, State Individual Income Tax, 1970 and 1974.

Increases in average gross incomes for four Arrowhead counties (St. Louis, Lake, Cook, and Aitkin) were greater than the state average, while the other three counties (Koochiching, Itasca, and Carlton) equaled or were below state averages for percent change in average gross incomes.

15.4 STUDY OBJECTIVES

The economic significance of potential Study Area copper-nickel development is evaluated by computer simulation in terms of economic indicators. Indicators used are industry gross output, employment, and earnings from wages, salaries, and proprietorships, which are measures of Study Area economic activity and its effects on individuals and businesses. Gross output, the dollar value of production by Study Area industries represents business activity and is often interpreted by government officials, businessmen, and individuals as a measure of an area's economic health. Employment and earnings statisics are measures of the economic welfare of individuals. Evaluation of the potential economic significance of Study Area copper-nickel development in terms of these indicators is the objective of the regional economic study.

15.5 STUDY METHODOLOGY: SIMLAB

SIMLAB is a computer-based regional socio-economic model developed to forecast the potential effects of events like copper-nickel development (Meagher 1979). The model is a mathematical representation of the Study Area economy. It consists of mathematical expressions representing linkages between regional industries and relationships between production by regional industries and their national and regional markets. SIMLAB is called a simulation model because it forecasts the effects of hypothetical situations or scenarios supplied by its user.

Before forecasts can be made, SIMLAB must be implemented for a particular study area by assembling numerical data on gross output or production by regional industries, employment, earnings, labor force, and population. SIMLAB is then adjusted so the forecasts it generates follow trends in this data. When the SIMLAB user supplies scenarios concerning future deviations from the trends, SIMLAB responds with forecasts of future study area industry gross output, employment, earnings, labor force, population and a number of other socio-economic variables.

At least two SIMLAB forecasts--baseline and development--are needed to measure potential effects from copper-nickel development. The baseline forecast assumes no copper-nickel development and business-as-usual in other Study Area industries. The development forecast includes a copper-nickel development scenario. Several different development scenarios are considered in this study. Differences in Study Area gross output, employment, and earnings in the two forecasts are measures of the potential effects of copper-nickel development.

SIMLAB is designed to measure the direct, indirect, and induced economic effects of events like copper-nickel development. Direct effects are changes in gross output, employment, and earnings experienced by Study Area firms furnishing supplies, materials, and services directly to the copper-nickel mining industry. Other area business firms are indirectly affected if they furnish goods and services to directly affected firms. Household spending of copper-nickel payrolls would generate induced effects on the retail, wholesale, and service sectors of the Study Area economy. A review of SIMLAB components reveals the multiplicity of economic events taken into account by the model.

SIMLAB consists of a core input-output module which interacts with a series of other modules to form a regional simulation model with up to 95 industry groups.

Input-output models are explained below. Fifty-two sectors of industrial detail were used to forecast copper-nickel development impacts. Additional industry detail was unnecessary due to the limited number of different industries in the Study Area.

Relationships between SIMLAB modules are shown in Figure 3. The functions of the modules are as follows:

a) The market module links the Study Area economy with the national economy so that SIMLAB embraces an economic base theory of regional economic activity.

b) The investment module contains relationships for measuring and forecasting spending by regional firms for plant and equipment.

c) The demand module relationships represent the consumption behavior of households and other non-industrial users of regional products and services. The behavior of industrial users is taken into account by the input-output based production module.

d) The employment module relationships link the volume of production in each sector to employment in each sector.

e) The value-added module relationships estimate the pool of funds from which depreciation, business taxes, and investment in new plant and equipment must be drawn.

f) The labor force module relationships represent the demographic and economic forces determining regional labor supply and demand.

g) The population module relationships include variables representing the demographic and economic forces determining changes in regional population.

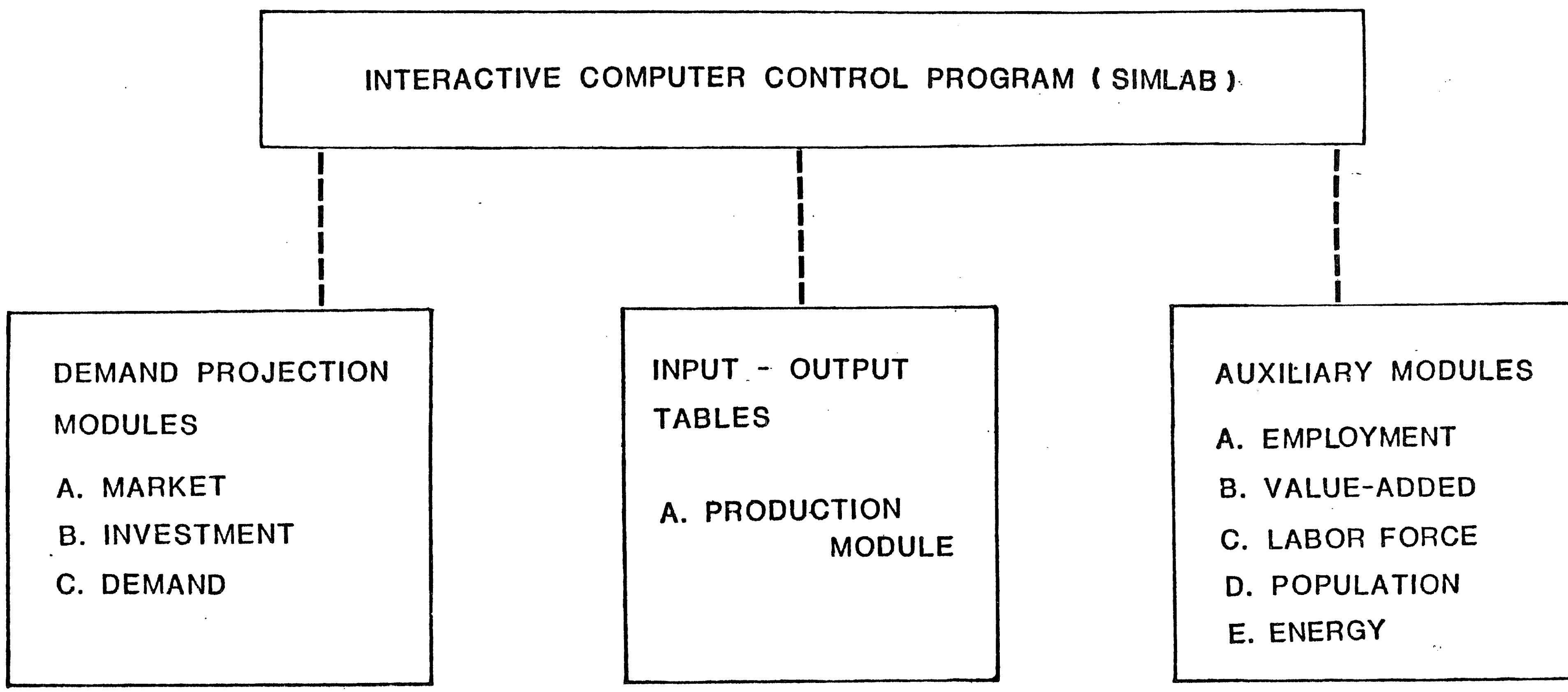
h) The production module contains the core regional input-output model which interacts with the other modules.

The eight sets of relationships in SIMLAB are derived from a wide range of data. A reference manual is available in which data sources and computational procedures used in deriving SIMLAB model variables, relationships and assumptions are described. (Meagher 1979).

Figure 3

FIGURE 3

SIMLAB MODULE TYPES



15.5.1 Assumptions Behind SIMLAB Forecasts

SIMLAB forecasts are obtained from the programmed interactions among the modules which are consistent with the economic base theory of regional economy activity (Isard 1960). Economic base industries are those producing goods and services in excess of regional requirements for sale outside the region. Thus, an inflow of dollars on regional balance of payments account is generated. This inflow sustains regional economic activity and, if the inflow increases, the level of regional activity also increases. The taconite industry is an economic base industry. SIMLAB analysis of the Study Area economy reveals that in addition to the taconite industry, construction, apparel, logging, printing and publishing, machinery manufacturing, railway transportation, truck transportation, communic-tions, wholesale and retail trade, and some services also exhibit economic base activity. However, the taconite industry generates more than three times as much money inflow as all of the other Study Area economic base industries combined. Thus, the National market for the steel produced from taconite has the critical role in determining the level of economic activity in the Study Area.

SIMLAB provides a method of measuring linkages between the taconite industry and other area industries through the relationships programmed into its modules. For example, growth in the National economy will lead to growth in the demand for steel and so to growth in the demand for Study Area taconite. A forecast for growth in the Study Area taconite industry based on industry expansion plans is an important assumption upon which SIMLAB forecasts of future Study Area employment and earnings are based. These expansion plans are described in Volume 5-Chapter 5, Minelands.

In the SIMLAB model, forecast growth in Study Area taconite production and export leads to calculation, in the production module, of additions to production by

Study Area supplying industries needed by the taconite industry if it is to expand output. Should these calculated increases exceed Study Area plant capacity, or should they require labor inputs in excess of available labor supply, SIMLAB will calculate the maximum output obtainable under the existing constraints. In case of excess demand for labor, migration and commuting into the region will be forecast by the labor market and population modules. An excess supply of labor results in forecasts of out-migration and regional population decline.

15.4.6 Input-Output Tables

The SIMLAB production module includes the critically important measures of Study Area inter-industry linkages which permit a complete accounting of the effects of changes in the level of exports have on the economy as a whole. These linkages are represented by the input-output table. The Study Area input-output table was constructed at the University of Minnesota using special computer programs (Hwang 1976). Although these computer programs are unique, their general methodology is extensively discussed in published literature (Morrison 1974). The resulting table has a total of 52 industries and is too cumbersome to be presented for illustration here (Meagher, Maki 1979).

An illustrative input-output table is shown in Table 3 in which interindustry linkages are shown for a hypothetical three-industry economy. All numerical values are given in millions of dollars. Thus, the $2 million listed under the manufacturing column and the services row means that $2 million worth of services are acquired by the manufacturing sector from the services sector for use in the production of manufactured goods. The manufacturing sector also purchases $4 million worth of agricultural products, $7 million worth of its own products, $6 million worth of labor services from households, and $5 million of imports from outside the region -- a total of $24 million worth of purchased inputs. The entry in the manufacturing row of the gross output column indicates that the output of the manufacturing sector was sold for a total of $24 million. Of the $24 million of product, $2 million was purchased by local households and $5 million was exported to buyers outside the area.

Table 3

Since total manufacturing costs are listed as $24 million, it may seem as though the manufacturing industry made zero profit. This is not so because the primary inputs from the household sector are defined, in this illustration, to include stockholder's equity, or dividends, and retained earnings. Thus, the input-output table is a balance sheet of historical facts. Like a balance sheet, the illustrative input-output table summarizes the results of business activity carried on over one period of time-defined to be one year for the Copper-Nickel Study.

Programmed into the SIMLAB system, the Study Area input-output tables makes it possible to trace the effects on the economy of expansion by an existing or new industry. Once expansion gets underway, supplies and materials are purchased from regional supplying industries, increasing the volume of interindustry transactions. When these industries expand their output, they require more intermediate goods from the industries supplying them. The input-output table prescribes how much the output of all industries supplying an expanding or new industry must increase. As already explained, this is the function of the production module in the SIMLAB system.

Table 3. Illustrative input-output table ($ million).

PRODUCING SECTOR	PURCHASING SECTOR: INTERMEDIATE DEMAND: Agri-culture	Manu-facturing	Services	FINAL DEMAND: House-holds	Export	GROSS OUTPUT
Agriculture	2	4	3	7	0	16
Manufacturing	5	7	5	2	5	24
Services	3	2	4	8	3	20
Households	4	6	8	0	3	21
Import	2	5	0	4	--	11
Total (gross) Outlay	16	24	20	21	11	92

Table 3 provides an example of how an input-output table prescribes how much the output of industries supplying an expanding or new industry must increase. There, each dollar's worth of agricultural production requires 31 cents worth (i.e. $5 \div 16 = .31$) of manufactured products. This relationship is called a technical coefficient of production. Use of the technical coefficients of production is based on certain assumptions:

1) If the coefficients of production are to represent the mix of inputs used per unit of output in the production process, then the relative prices of all goods and services must remain fixed since microeconomic theory demonstrates that in a competitive economy the mix of inputs used by producers, and the mix of outputs produced, will vary with changes in relative prices. It is important to note, however, that it is relative prices or price ratios which matter, not the overall level of prices. If all prices double, relative prices are unaffected. Thus, to the extent that all prices move together, the constant relative price assumption is realistic for the purpose of comparison.

2) Interpreting the coefficient as representing the value of goods a producing industry must purchase from a supplying industry to produce one dollar's worth of output implies that this relationship holds true at all levels of output. However, microeconomic theory demonstrates that changes in the scale of output may change the efficiency with which one or more inputs is utilized, changing the yield of product per unit of input. This phenomenon is referred to as economies of scale. Input-output analysis ignores economies of scale, an assumption which becomes generally more accurate as changes in scale of production become smaller.

Because relative prices and/or the scale of production generally change over periods of time, these assumptions of input-output analysis can cause errors in projections made using input-output information. Provided the commodity flow data in the input-output table is accurate, the technical coefficients are valid statements of historical fact. However, if the coefficients are used to analyze events in a later year, then the possibility of error arises either from changes in relative prices or from economies of scale. There is insufficient data on the Study Area economy to determine if relative prices have changed or if substantial economies of scale in Study Area industries are possible between the present and the year 2000, the period of time covered by the copper-nickel development scenarios. In the absence of evidence to the contrary, it is assumed that the coefficients will not change significantly. Indeed, in other input-output tables, the coefficients seem to represent relatively enduring characteristics of industrial production for reasons which are the subject of considerable research (Cherery 1959).

15.5.3 Limitations of SIMLAB Forecasts

Apart from possible errors stemming from use of the input-output methodology, SIMLAB forecasts of the effects of copper-nickel development have an important limitation in that they must be interpreted as forecasts of potential effects. There are two reasons for this. First, forecasts of increases in Study Area gross output, employment, and earnings resulting from the direct, indirect, and induced effects of copper-nickel development must be interpreted as only potential. They are dependent on public policy (government) and private (corporate) decisions as to if, when and to what extent copper-nickel development will occur. SIMLAB does not forecast such decisions. Second, the SIMLAB forecasts depend on the reasonableness of the copper-nickel development scenarios. The development scenarios used in this study are hypothetical models designed to represent the magnitude and range of potential impacts which may occur as a result of copper-nickel development. They do not represent any specific copper-nickel proposals nor should they be intrepreted as endorsements. The scenarios are realistic in that the relationships among capital cost, employment, operating costs, salaries, recovery rates, and production reflect the latest available data for this industry.

15.6 COPPER-NICKEL DEVELOPMENT SCENARIOS

A development scenario is an assumption concerning possible future copper-nickel development. There are a number of possible minesites in the development zones shown in Figure 1. At least three different kinds of mines appear possible in view of what is known about the copper-nickel resources. The models developed based on these possibilities are an open pit mine producing 20 million metric tons of ore annually, a 11.33 million metric ton per year open pit mine operating in conjunction with a 5.35 million metric ton per year underground mine to produce 16.68 million metric tons of ore per year, and a 12.35 million metric ton per year underground mine. Table 4 shows the estimated lifespan for each mine type given the quantity of copper-nickel resources known to be present in each development zone. A mine lifespan of twenty years or more would permit amortization of invested capital at the straight-line rate of five percent per year. This makes some sites relatively more attractive than others on economic grounds since they hold enough mineralization for a relatively long period of operation.

Table 4

A long period of operation does not guarantee mine profitability. A long period of operation helps assure mining companies that they could recover their invest-

Table 4. Life span (in years) per development zone, assuming a given annual mine production.

MINE MODEL (million mtpy)	COMBINATION Open Pit 20.00	Open Pit 11.33	Underground[a] 5.35	Underground[a] 12.35
Zone				
1	23.9	42.1	53.5	23.2
2	17.0	30.0	237.4	100.6
2&3	(3.8)[b]	(6.8)[b]	(7.3)[c]	(3.2)[c]
3	13.2	23.3	10.9	4.8
4	11.6	20.5	78.5	33.9
5	5.6	9.8	33.5	14.5
6	5.6	9.8	7.0	3.0
7	0.6	1.0	--	--

[a]These numbers are calculated assuming 23 percent of resource will be left in place for underground mining roof support.

[b]These figures show the number of mine production years lost because resource is under water and within 600 feet of surface.

[c]These figures show the number of mine production years gained by assuming 40 percent (600-1,000 ft. level) of resource in this zone can be extracted by underground technique.

(Volume 3-Chapter 2)

ment in mining and processing facilities. Profitability would vary among the potential minesites because of different ore grades, management policy, capital investment required, and ore accessibility. This is the subject of Volume 5-Chapter 17 of this report. Profitability differences and different management views of the best time to risk a new venture suggest that the mines may be opened at different times. Thus, realistic development scenarios deal with alternative numbers of mines open at any one time. Unnecessary complexity can be avoided by examining a set of scenarios which demonstrate the range of possibilities.

In summary, the scenarios used in the SIMLAB study are as follows. First, single mine development scenarios are considered. These consist of a 20 million metric tons per year open pit mine, a 16.68 million metric tons per year open pit/underground combination mine, and a 12.35 million metric tons per year underground mine. All operations are assumed to be fully integrated with concentrating mills and smelter/refineries. Each alternative complex is assumed to be the only development in the Study Area. The forecast economic effects from these development scenarios represent what can be expected from a limited amount of copper-nickel development, but smaller mines or no smelter/refineries in the Study Area is also a possibility resulting in reduced economic effects.

Second, the forecast effects from multiple mine development scenarios are considered. This set of scenarios has the potential for a larger range of effects than the single mine scenarios. SIMLAB forecasts of the potential economic effects from these alternative development scenarios follow.

15.7 POTENTIAL IMPACTS OF COPPER-NICKEL DEVELOPMENT ON THE STUDY AREA AND REGIONAL ECONOMIES

The potential impacts of copper-nickel development on the economies of the Study

Area and the Region will be large. In keeping with the economic base analysis methods used elsewhere in this report the potential impacts are classified as either "direct" or "indirect". A differentiation between the two types of economic impacts provides a clearer distinction between cause and effect, action and reaction.

The economic base theory of regional economics simply stated, divides any economy into basic and nonbasic activity. Basic activity attracts or generates dollars from outside the boundaries of the region and therefore supports all other economic activity. A business or industry which exports its goods and/or services from the region is a base industry. Alternatively, an industry, such as tourism, which attracts consumers from outside the region is also a basic industry. All other economic activity provides support (i.e. provides goods and services which are consumed by local demands) for the regional economy.

In this chapter, "direct" impacts are loosely associated with basic economic activity. That is, direct impacts are those attributable directly to the copper-nickel opertion itself: its employment, payroll, and business expenditures. They are distinct from the existing regional economy and as such, are easily estimated.

The "indirect" impacts are closely associated with the nonbasic activity of economic base theory: although some of what is called indirect activity here will result in increased exports from the region. The indirect impacts are those which stem from the original direct economic activity. They are generated from the increase in copper-nickel related population and its associated demands, the increase in disposable income in the region and the increase in business expenditures by the copper-nickel operation. Because it is an expansion of the existing economic system, and not distinct from it, the indirect impact is much harder to estimate and as a result the projections offered here are more subject to question.

In terms of indirect impacts, this chapter focuses on three crucial economic indicators: gross output, employment and earnings. Gross output is a measure of the value of final and intermediate goods and services produced and sold by the economy of the Study Area. It does not correspond with the actual selling price of a final product but is an accounting of all the economic activity that went into producing the product including profits at different stages of manufacturing.

Employment is the number of occupied jobs in the Study Area which may be filled by both residents and incommuters.

Earnings are the total wages, salaries, and the proprietor's salary and profits for small businesses for any economic sector, and is an indicator of the impact of economic changes on households.

The chapter also addresses the key relationships among variables and with regard to time. As will be seen, timing is a vitally important factor in dealing with the potential impacts of copper-nickel development.

15.7.1 Direct Impacts of Copper-Nickel Development on the Study Area Economy

15.7.1.1 Employment and Payroll--The development of a single, fully-integrated copper-nickel operation--mine, mill, smelter, and refineries--will provide from 2,071 to 2,584 jobs in the Study Area (Volume 2-Chapter 5). Three operational models have been developed to analyze the regional economic impacts of development. The open pit model requires 2,071 employees to produce 100,000 mtpy of copper and nickel metal. A combination open pit and underground model producing the same amount of metal calls for 2,287 employees while a completely underground model would require 2,584 employees to produce 100,000 mtpy of metal.

In addition to the operational work force, a construction work force would be required for 4 to 5 years as the mineral producing facilities are built. This short-term work force will peak with 1,800 (underground model) to 2,547 (open pit) employees. There will be some overlap of the construction and operation work forces so that total employment may reach from 2,902 (open pit) to 3,255 (combination) employees. Figure 4 shows the estimated work forces for each of the three scenarios.

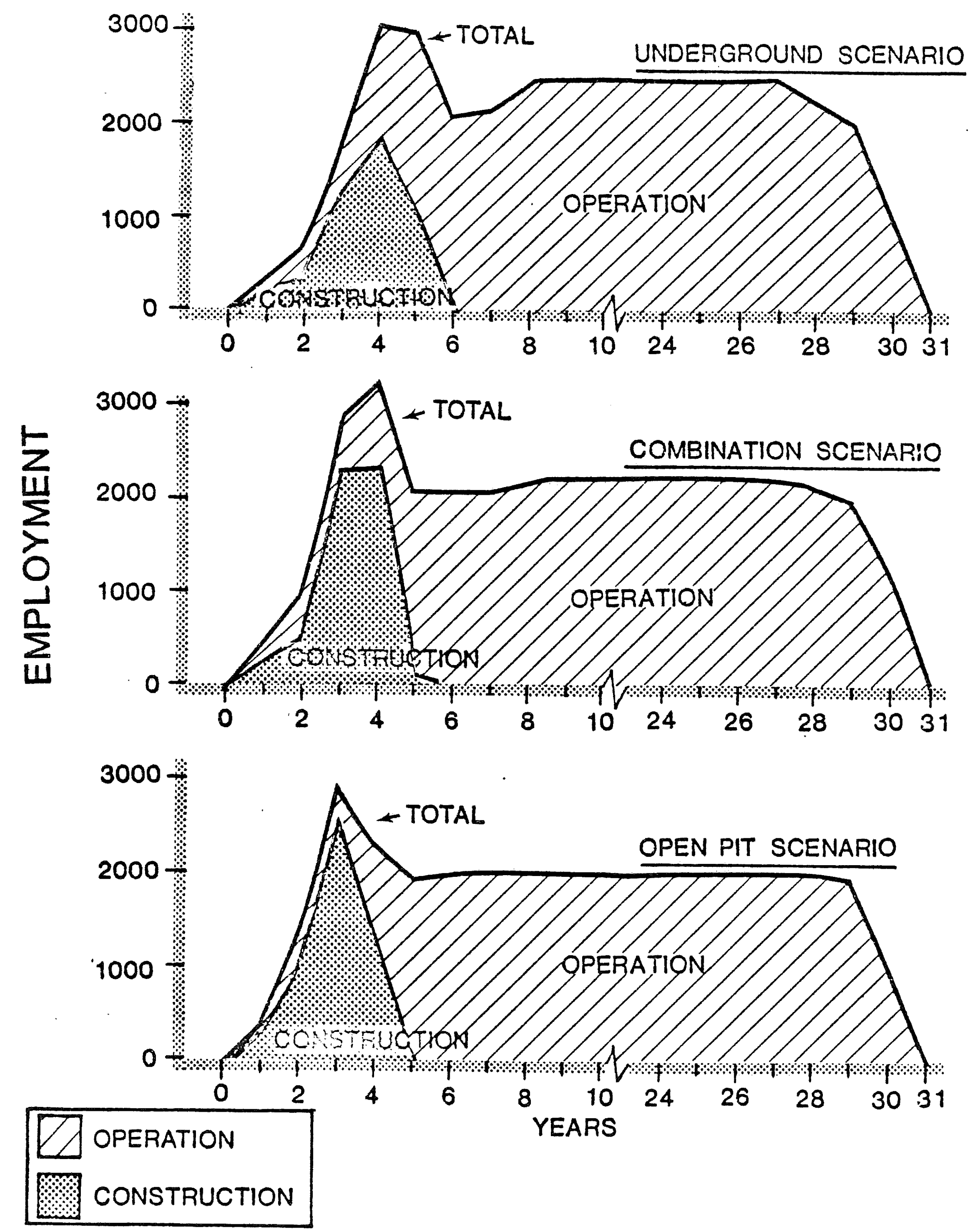
Figure 4

A crucial period of time for many of the decisions regarding economic development in the Study Area will be between years two and eight of copper-nickel operation. Figure 4 shows that the total employment (and as a result, total payroll and consumer expenditures) reaches its peak very early in the life of the operation because of the overlap of construction and operational work forces. The employment level of peak production is less than this early peak.

Local businesses and government officials must be prepared to accommodate this early peak of employment (and its concomitant demands) while keeping in mind that the initial peak will be followed by a period of time (three to five years) when employment and economic activity will be considerably less than that experienced very early in the mine life. In fact, employment levels of a single operation may never again reach the peak experienced during the construction phase.

FIGURE 4

ESTIMATED DIRECT EMPLOYMENT IMPACT OF THREE COPPER-NICKEL DEVELOPMENT SCENARIOS



The annual payroll of the operation at full employment may range from $40.8 million (open pit) to $52.8 million (underground). The average salary ($1977) will be higher for the underground model, $20,440 per year, than for the open pit model, $19,680. This is due to the more technical nature of underground mining.

Construction workers would receive about $24,500 per year. At peak employment, the construction payroll would range from $44.1 million (underground) to $62.4 million (open pit).

If 60 percent to 70 percent of gross salary is assumed to be disposable income, from $24.5 million to $37.0 million would be available each year for expenditure by the operation's work force at full employment. An additional $26.5 million to $43.7 million of disposable income would be generated during the year of peak construction activity.

It is estimated that most of the operational work force will reside within the Study Area, although this will vary according to the location of the copper-nickel complex (see Volume 5-Chapter 7, Residential Settlement for a detailed examination of this subject). It is expected that more employees will reside within the Study Area for operations located in the northern-most Resource Zones than for operations located in the southern zones. In a study of taconite workers (Donaldson 1977) it was found that 92 percent of the employees of Erie and Reserve Mining Companies (located near the copper-nickel resource zones) lived within 20 miles of their job site.

Much smaller percentages of the construction work force will be or will become permanent residents of the Study Area. As a result, much of the construction payroll will "leak" out of the Study Area as transient construction workers send money to their permanent homes. The impact of the construction payroll on the

Study Area would then be much smaller than the impact of the operational worker's salaries.

In a study of the Ely area economy, it was found that approximately 70 percent of the areas disposable income was spent in the local economy (Lichty 1978). If this figure is applied to the operation work force described above, from $17.2 million to $25.9 million of local expenditures would be generated in the Study Area each year, assuming that all employees reside in the Study Area. If 90 percent of the employees reside in the Study Area, this range would be reduced to $15.5 million to $ 23.3 million ($1977).

The estimated level of personal consumption expenditure for the Study Area in 1978 was $93.9 million. The estimated expenditures resulting from a single copper-nickel operation's payroll represents 17 to 25 percent of the Study Area's 1978 level of expenditures.

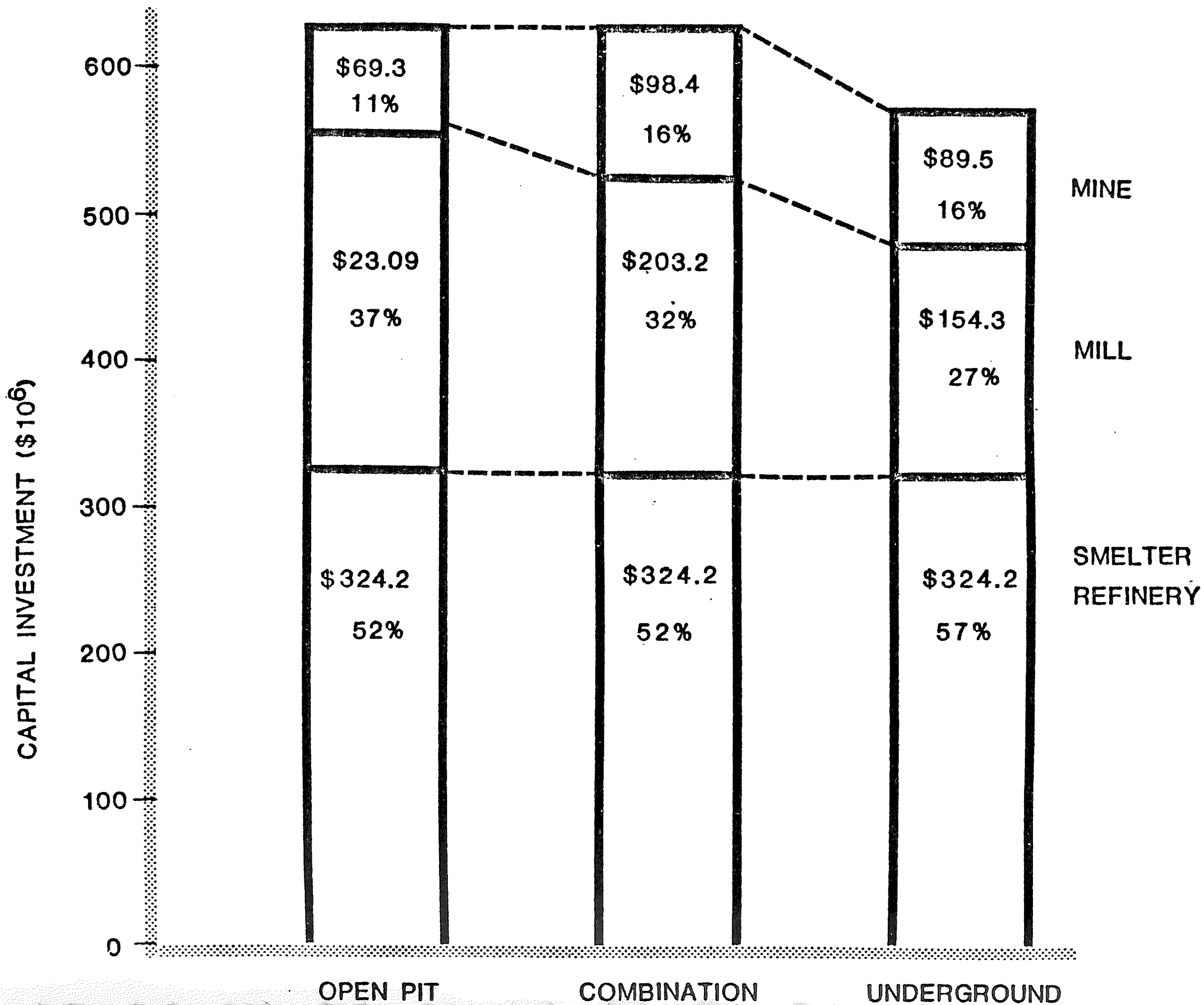
15.7.1.2 Capital Investment--The capital investment ($1977) required to produce copper and nickel metal is enormous. A total estimated investment of $568 to $626 million is necessary to produce 100,000 mtpy of metal. In each scenario the investment for the smelter/refinery is identical, $324.2 million. The difference in total investment required is due to the method of mining and the concentrating process necessary to handle various ore grades. The capital investment for an underground mine/mill, $243.8 million, is the smallest of the three hypothetical scenarios, while combination open pit and underground mine/mill operations would be the most expensive at $301.6 million. Figure 5 shows a comparison of each scenario's capital requirements.

Figure 5

FIGURE 5

ESTIMATED DIRECT COPPER-NICKEL CAPITAL INVESTMENT

($ 1977)



15.7.1.3 Corporate Activity--Each of the three scenarios is designed to generate about $282 million ($1970) in gross annual output (100,000 mtpy of metal at 91¢/pound copper and $2.10/pound nickel ($1977) plus some precious metals). Both output and employment have been adjusted slightly from the models described in Volume 2-Chapter 5. This is necessary to reflect the output/employment relationships used within the SIMLAB computer model.

The indirect economic benefits to Minnesota of corporate activity are most easily recognized in the payroll, taxes, and royalties which would be paid by the operation. Corporate taxes of about $12 million per year, royalties depending on mineral ownership plus personal income and use taxes paid by the operation's employees of $1.6 million would be added to the state treasury (see Volume 5-Chapter 12 for further detail).

In addition the mining company would make operating expenditures other than payroll. These are likely to range from $56.1 million to $61.5 million ($1977) each year. While it is unlikely that a significant portion of the equipment and supplies necessary for a copper-nickel operation will be produced in Minnesota when development is in its early stages this infrastructure of supply may be developed at later stages. Even though most supplies may not be produced by Minnesota companies they will be distributed through them, probably by the same companies which serve the taconite industry. These companies will benefit from copper-nickel development in the amount of their earnings.

Table 5 is a summary of some of the important economic indicators of the three integrated mine models.

Table 5

Table 5. Summary of estimated mine model economic indicators.[a]

	20,000,000 mtpy OPEN PIT SCENARIO	16,680,000 mtpy COMBINATION SCENARIO	12,850,000 mtpy UNDERGROUND SCENARIO
Employment			
Operation			
Peak	2,071	2,287	2,584
Length	27 yr	27 yr	26 yr
Payroll ($ million)	40.8	46.3	52.8
Average salary ($)	19,680	20,220	20,440
Construction			
Peak	2,547	2,307	1,800
Length	4 yr	5 yr	5 yr
Payroll ($ million)	62.4	56.5	44.1
Average salary ($)	24,500	24,500	24,500
Capital Investment			
Mine/Mill ($ million)	300.2	301.6	243.8
Smelter/Refinery ($ million)	324.2	324.2	324.2
Total ($ million)	624.4	625.8	568.0
Gross Output ($ million)[b]	285.1 ($1970)	285.1 ($1970)	285.1 ($1970)
Earnings ($ million)[b]	30.4 ($1970)	33.6 ($1970)	37.9 ($1970)
Operating Expenditures[c] ($ million)	56.1	58.7	61.5

[a]All dollar in 1977 terms unless otherwise indicated.
[b]Output from operations in 1995.
[c]Other than employee compensation.

15.7.2 Multiple Mine Scenarios

The direct impacts of more than a single fully integrated copper-nickel operation would be multiples of the single operation impacts. Four open pit operations of the same size would, for example, employ four times the number of workers as the single open pit scenario and produce four times the gross output. A scenario of one each of the open pit combination and underground models would produce direct impacts equal to the sum of the impacts of each single scenario.

Table 6 shows the economic impacts which would result directly from up to four fully integrated combination open pit and underground operations (the mid-range scenario of the three presented above).

Table 6

Four copper-nickel operations would require employment levels (9,148) greater than the estimated 1987 taconite employment in the Study Area (8,080). Taconite employment for the entire Iron Range is projected to be 11,710 by the year 2000, or the equivalent of about five fully integrated copper-nickel operations.

The timing of development can be an important consideration in the degree of impact from any multiple mine scenario. As mentioned above the period between the construction and operation employment peaks is of extreme importance in terms of planning business and community intrastructure. If timing of the sequence of developments so occurred that the total period of construction is prolonged, the drop in employment immediately following the construction employment peak would be eliminated, or at least minimized, between developments.

Figure 6 shows the employment impacts of several alternative development sequences of three fully integrated combination open-pit and underground operations.

Table 6. Economic impacts[a] of multiple mine development.[b]

	ONE OPERATION	TWO OPERATIONS	THREE OPERATIONS	FOUR OPERATIONS
Employment				
Operation	2,287	4,574	6,861	9,148
Construction (man-yr)	3,214	6,428	9,642	12,856
Payroll ($ million)				
Operation	46.3	92.6	138.9	185.2
Construction (total)	78.7	157.5	236.2	315.0
Capital Investment ($ million)	625.8	1251.6	1877.4	2503.2
Gross Output ($1970 million)	285.1	570.2	855.3	1140.4
Earnings ($1970 million)	33.6	67.2	110.8	134.4
Operating Expenditures[c]	58.7	117.4	176.1	234.8

[a]Figures represent peak productivity unless otherwise noted.
[b]$1977 unless otherwise noted.
[c]Other than employee compensation.

One scenario (line A on the graph) shows the impacts if all three operations were under construction and operating simultaneously (a highly unlikely possibility). The other two scenarios show the effects of staggered development, line B on the curve shows a three year period between construction start-up while line C shows the effects of a six year sequence.

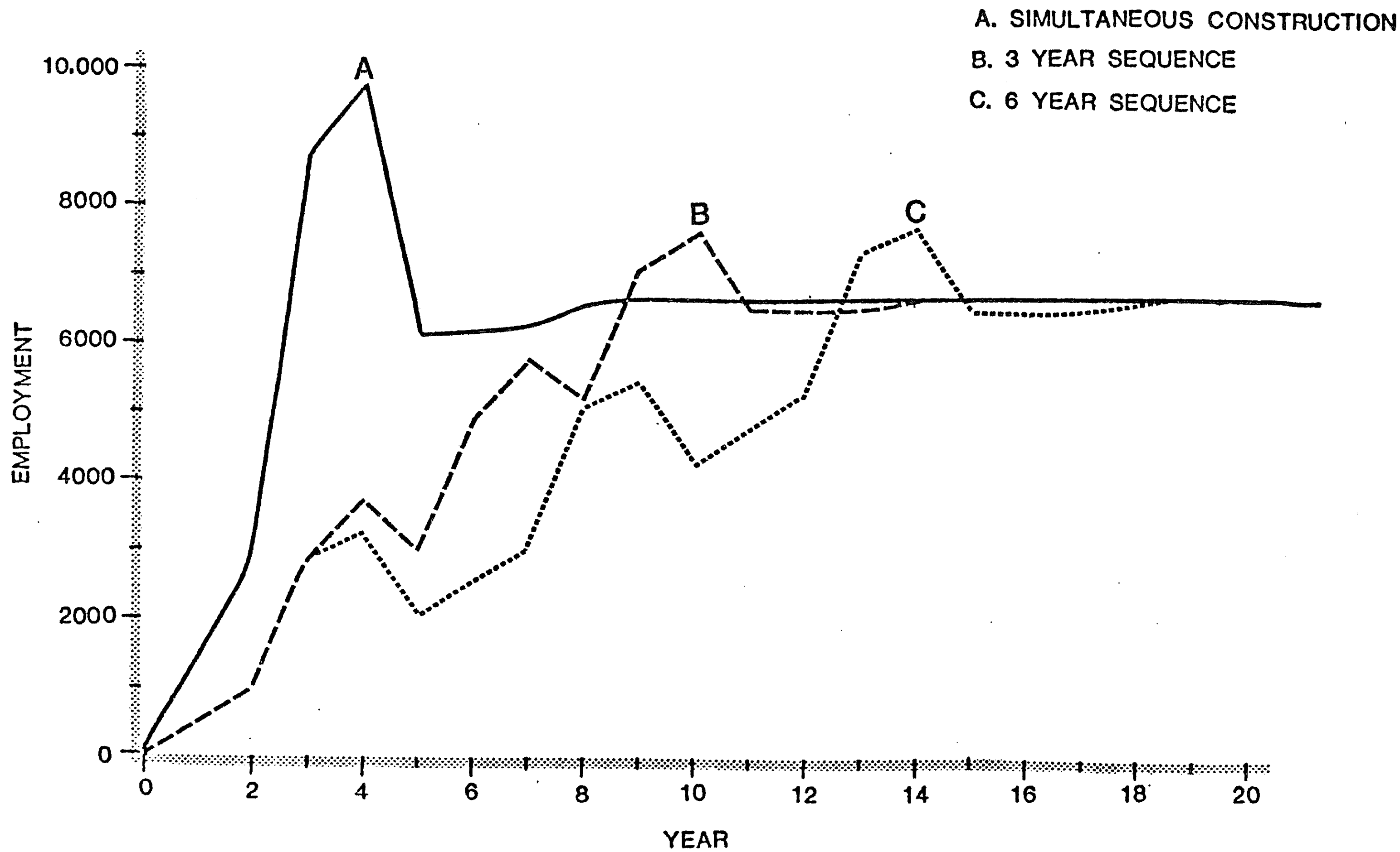
Figure 6

The figure clearly shows the problems likely to occur if more than a single operation is under construction at the same time. The peak construction employment is nearly 50 percent larger than the peak operational employment. Such a scenario would require large amounts of temporary accomodations for this construction work force and would place extreme stress on the infrastructure of the Study Area. This type of development, in effect, occurred between 1972 and 1977 when several taconite expansion projects were under construction simultaneously. During that period, there were significant housing shortages. Construction workers were living in tents and campers and occupied nearly every motel room along the Iron Range. In addition there were general inflationary pressures, especially in housing, and increases in such social indicators as crime and marital problems. Each of these stresses may be attributed to the pressures which the large construction work force placed on the existing patterns of life and infrastructure of the Iron Range.

Figure 6 shows how a staggered development sequence may minimize the disparity between peak construction and operation employment. Given the scenarios presented here it is not possible to eliminate the initial construction peak or the decline in the work force that immediately follows. But it is possible to minimize these impacts and reduce the stresses which these forces would have on the Study Area economy.

FIGURE 6

ALTERNATIVE DEVELOPMENT SEQUENCE FOR THREE INTEGRATED OPERATIONS



15.7.3 Indirect Impacts of Copper-Nickel Development on the Study Area Economy

The indirect economic activity induced by copper-nickel development will, in some considerations, result in impacts on the Study Area greater than the direct activity of the copper-nickel operation itself. Expansion of the base economy of the Study Area--in this case, mining--will cause the supporting economic sectors of the area to adjust to the new level of basic activity. Thus, the total economic impact of a copper-nickel operation will be much greater than the direct impacts of the mining operation itself. Most Study Area businesses, from the grocer to the hardware store owner will indirectly benefit from the base economy expansion.

The indirect economic activity will result primarily from the increase in disposable income in the Study Area and an increase in business expenditures as the payroll of the copper-nickel work force begins to circulate throughout the economy and the copper-nickel operations purchase supplies and equipment from area dealers. As expenditures in the area increase, local businesses will have to adjust. To accomodate the new demands for goods and services, additional employment and capital facilities may be required. These in turn will foster additional economic demands and the "multiplier" effects of the initial copper-nickel operation will ripple throughout the economy. In the end it will impact to a degree upon virtually every economic sector of the Study Area.

Of course, some sectors will feel the effects of copper-nickel development to a greater degree than others. The figures presented below indicate that the Service, Trade and Government sectors will experience the greatest amount of indirect economic activity. This seems reasonable because the indirect effects of development are mostly people related. These sectors will respond to the demands of new copper-nickel and other induced employees in the area.

Three economic indicators previously defined (gross output, employment, and earnings, see page 20 for definition) are analyzed below for each of the three hypothetical integrated copper-nickel developments. Figure 8 shows the direct, indirect and baseline levels for the three indicators for each of the scenarios. Figure 8 shows only the impacts of the operation of the copper-nickel complex. They do not include the impacts of construction in the preoperation stage because the assumptions about what would happen to the construction work force once construction is concluded make modeling this activity extremely difficult. The direct impacts of construction have been discussed above and they would appear as a bump on the front end of each of these curves. However, the indirect impacts of construction will not be as great as the indirect impacts of operation because of the characteristics of the work force. Construction workers will likely be more transient than the permanent work force (though it is likely some construction workers will remain in the area to work in the operation itself) and as a result will have smaller families or be alone and spend less of their salary in the Study Area. This will not create the same magnitude of indirect demands for goods and services which the Study Area will experience during the operation of the copper-nickel complex.

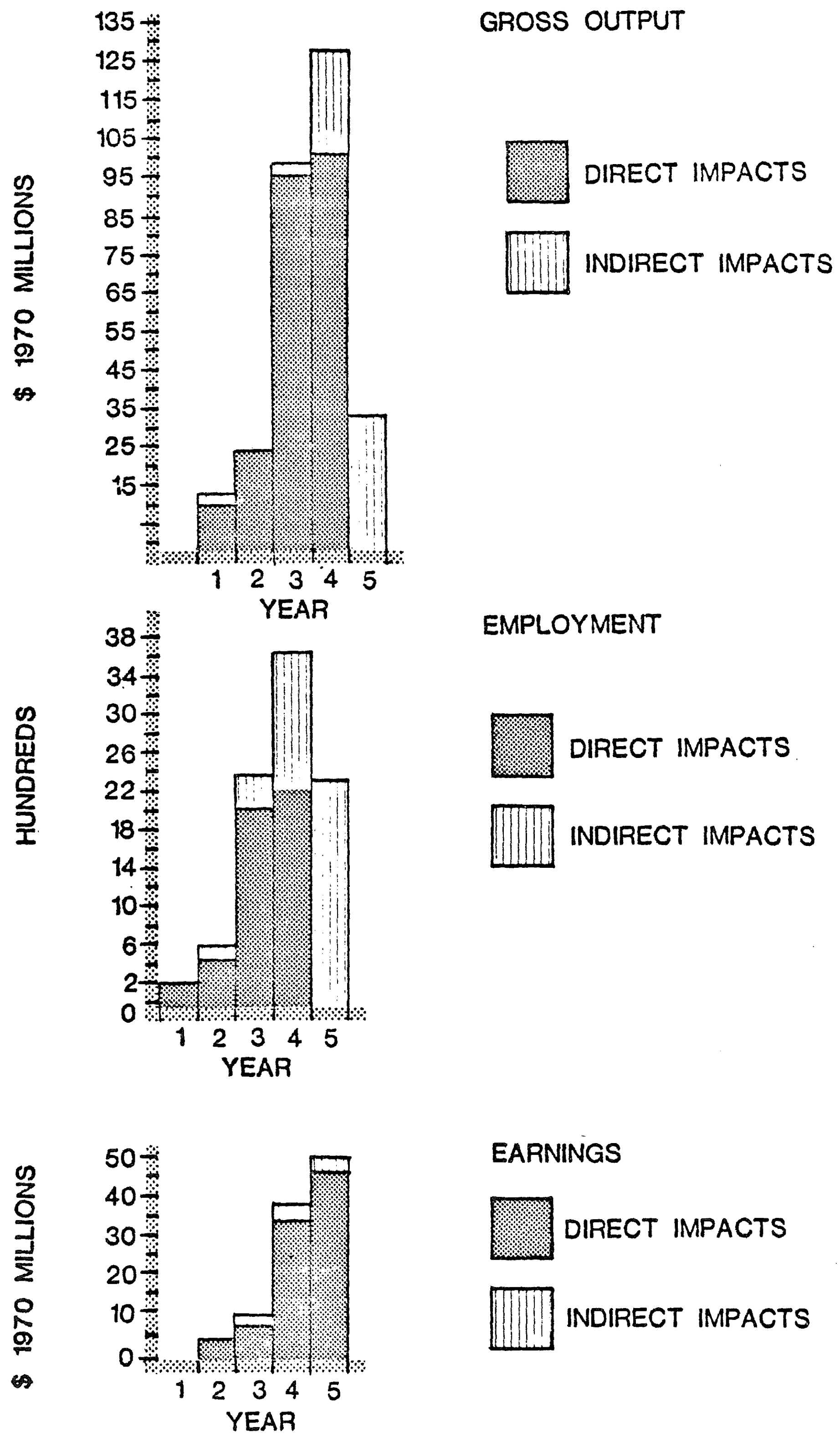
The indirect effects of the construction period are approximated in Figure 7. This data is from the construction of the combination open pit and underground development. It shows that there is little indirect impact relative to the operational phase.

<u>Figure 7</u>

Two interesting points regarding the timing of impact are indicated in the figures. The first is the lag of indirect impacts behind the direct. This

FIGURE 7

DIRECT, INDIRECT AND TOTAL IMPACTS ON GROSS OUTPUT, EMPLOYMENT AND EARNINGS BY THE CONSTRUCTION OF THE COMBINATION MINE MODEL



reflects the time of adjustment which is required for the local economy to recognize what is happening and make a responsive change. Secondly, earnings lag behind the other two economic indicators, indicating the time necessary for the economy to recover (in net terms) from the initial shock of development and its expansion requirements.

These figures should not be construed as representative of what will happen to the Study Area economy. Rather, they should be used to exemplify the relative importance of direct vis-a-vis indirect impacts, and the relationship between the development impacts and the baseline and the relative shape of the curves for each of the hypothetical copper-nickel scenarios.

The direct operational impacts, shaded in Figure 8, are those of the combination mine model. This scenario represents the mid-range of values among the three scenarios and is presented to show the relationship between direct and total impact for each of the three economic indicators.

Figure 8

Among the most important points examplified by Figure 8 is the shape of the respective baseline curves. Gross output is shown to increase steadily from a baseline level of about $760 million in 1980 to nearly $1,120 million in the year 2000, a 47 percent increase over 20 years ($1970).

The shape of the employment baseline curve is very interesting in light of what is happening to gross output. Because of projected increases in the productivity of labor (particularly in the taçonite industry) the employment necessary to produce the projected levels of gross output actually diminishes over time. The baseline curve peaks in the late 1980s (about the time copper-nickel mining could begin) and is projected to be at about a mid-1970s level by the year 2000.

Because of what is expected to happen to both gross output and employment, the earnings baseline curve levels off after 1987 at from \$320 to \$330 million (\$1970). The lower level of employment offsets the increase in gross output so that earnings stay surprisingly steady.

The figure shows many significant aspects of the projected economic impacts of copper-nickel development; among them the relative total impact of each development scenario, the relationship between direct and indirect impacts, the difference between the underground development scenario and the others and the impact of copper-nickel development in relation to the projected baseline employment levels for the Study Area.

The underground development scenario, among the three scenarios examined, is seen to have the greatest potential impact on the Study Area for each of the three economic indicators. This can be attributed to its higher employment requirements over the life of the operation, which more than offset its smaller capital and construction costs. The total impact of the development, then, appears to be much more dependent on the size of its operational work force than any of the other direct impacts.

The underground scenario also behaves a little bit differently than the others because it takes longer to bring the mining operation to a full production level. As a result the impact of this scenario starts out small relative to the others and peaks at a later stage in the life of the operation. This would probably serve to reduce the negative impacts of a rapidly expanding economy, allowing the infrastructure requirements of the area to be met at a less demanding pace.

Comparison of direct to indirect impact among the three economic indicators reveals vastly different relationships. The relationship of total to direct impact is often called the "multiplier" effect. A multiplier of two would indicate that the total impact of an event is twice that of the event itself. This, of course, means that with a multiplier of two, the direct and the indirect impacts are equal. The figures show that the multiplier for employment is much larger than the multipliers for gross output and earnings. The figures show that the indirect employment induced by development is projected to be significantly larger than the direct employment: at times three to four times as large. The indirect earnings are projected to be more than twice the direct earnings at some points over the life of the developments, while the indirect gross output is expected to be less than the direct gross output.

This points out an important aspect of these findings. The relationship of total to direct impact, the multiplier, is not static; it changes continuously over the life of each of the scenarios. However, for the sake of more detailed analysis, the direct and indirect impacts for each scenario are shown for a single point in time--1995, presumably by which time the economy will have reached some sort of equilibrium. These are shown in Figures 9.

An important planning consideration is the timing of copper-nickel development in relation to the projected downturn in Study Area employment levels if worker productivity increases occur as assumed. Because of expected improvement in the productivity of labor, particularly in the taconite industry, Study Area baseline employment is projected to peak in the late 1980s and decline thereafter. Properly timed copper-nickel development, especially multi-development opportunities, could have a stabilizing effect on Study Area employment and offset the economic problems and dislocations which could result from such a drop in baseline employment levels. Timing of copper-nickel development could also aggravate regional employment patterns if copper-nickel development peaks at the same time that taconite employment is projected to peak. In this case, employment of both mining sectors could be moving along similar paths, first increasing and then declining together.

Figure 9

The multipliers (ratio of total to direct impact) for the year 1995 of each scenario are indicated in Figure 9. For the three economic indicators shown, the multipliers are shown underneath their respective graph. They range from 1.48 for gross output (open pit scenario) to 4.53 for employment (underground scenario). Again, the impacts of the underground scenario are the largest among the three scenarios and the employment multipliers are much greater than those of earnings and gross output.

15.7.4 Detailed Examination of the Impact of the Open Pit Scenario

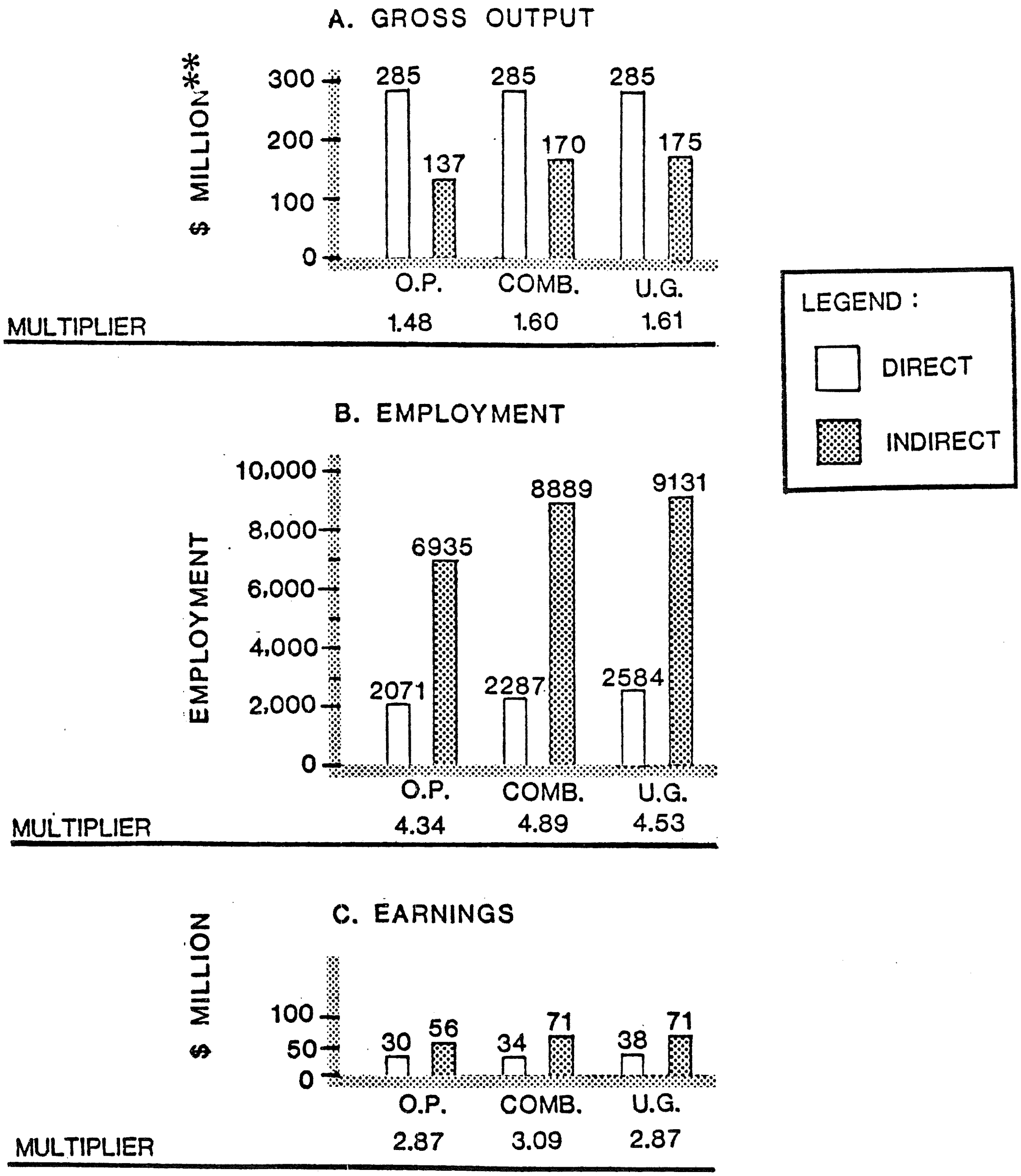
Copper-Nickel development will impact on some industries more than others and the timing of that impact may vary among the industries of the Study Area. For analysis purposes the economy of the Study Area is divided into thirteen relatively homogeneous economic sectors:

Agriculture
Iron Mining
Copper-Nickel Mining
Construction
Manufacturing
Transporation
Communication
Utilities
Trade
Finance, Insurance, Real Estate (F,I,RE)
Services
Other Industry
Government

These sectors are, in fact, condensations of much more detailed industrial sectoring. The condensation is necessary to handle the large quantity of data generated by the model and provide meaningful analysis for the reader.

FIGURE 9

ESTIMATED 1995 DIRECT AND INDIRECT IMPACT OF COPPER-NICKEL DEVELOPMENT*ON STUDY AREA ECONOMY



*20 X 10^6 MTPY OPEN PIT MINE - O.P.
16.68 X 10^6 MPTY COMBINATION OPEN PIT / UNDERGROUND MINE - COMB.
12.35 X 10 MTPY UNDERGROUND MINE - U.G.
ALL MINES ARE FULLY INTEGRATED INCLUDING MINE, MILL, SMELTER AND REFINERIES

**$ 1970

The implications of development on every sector of the economy for each of the three integrated scenarios would be extremely time consuming and costly to analyze. And the variations among the scenarios are not significant enough to warrant a detailed examination. To highlight the impacts on individual industries and to demonstrate the capability of the model, detailed analysis is presented here for the open pit scenario.

The impact of copper-nickel development on the industries of the Study Area is presented from two points of view. First, the change in economic activity within each sector is looked at in terms of its percent change from the baseline projections. Secondly, the change in specific industry economic indicators is viewed as a percent of the total development-related impact. This analysis provides the opportunity to see which industries may experience significant change from their projected baseline activity. It also highlights those industries which will be most significantly affected by development, relative to the total impact.

Table 7 shows the rank of economic sectors, other than copper-nickel, in terms of the projected percent change from the baseline economic indicators for the year 1995. It shows that there will be significant increases in economic activity in the Study Area for up to 9 of the 12 sectors shown. Nine sectors will experience, according to SIMLAB projections, increases of more than 20 percent of their baseline gross output activity as a result of the development of a single copper-nickel operation. Seven sectors will experience 20 percent increases from the employment and earnings baselines.

Table 7

Table 7. Rank of economic sectors of the Study Area in terms of the projected percent change from the baseline.

RANK	GROSS OUTPUT % CHANGE		EMPLOYMENT % CHANGE		EARNINGS % CHANGE	
1	Services	(56.2)	Services	(55.8)	Services	(55.7)
2	Government	(51.3)	Government	(51.4)	Government	(50.9)
3	Utilties	(48.2)	Trade	(44.4)	Trade	(43.6)
4	Trade	(43.5)	Other Industry	(31.7)	Other Industry	(39.0)
5	Other Industry	(39.8)	Utilities	(31.4)	Utilities	(34.3)
6	Communication	(25.5)	Communication	(24.0)	Communication	(24.8)
7	Manufacturing	(24.3)	Manufacturing	(21.5)	Manufacturing	(21.0)
8	F,I,RE [a]	(23.2)	Transportation	(18.7)	Transportation	(18.2)
9	Transportation	(21.5)	Agriculture	(10.0)	Agriculture	(13.1)
10	Agriculture	(11.1)	F,I,RE	(6.8)	F,I,RE	(9.5)
11	Construction	(2.2)	Construction	(2.3)	Construction	(2.5)
12	Iron Mining	(0)	Iron Mining	(0)	Iron Mining	(0.1)

SOURCE: SIMLAB output.

[a]Finance, Insurance, Real Estate (F,I, RE)

The economic sectors subject to the greatest impact for each of the indicators will be service, government and trade. In each case, these sectors are estimated to experience more than 40 percent changes from the baseline. Construction and iron mining, on the other hand, will feel virtually no impact at all from the operation of the copper-nickel complex. It must be pointed out that these estimates are for a point in time well past the actual construction of the complex. During the copper-nickel construction period and the initial years of operation, the region's construction industry will experience considerable growth.

Table 8 shows the impact on each economic sector in terms of its share of the total impact resulting from the open pit scenario. The table shows much more concentration of the impact than is shown in Table 7. Four economic sectors--trade, service, manufacturing and government--are top ranked for each of the indicators and represent the concentration of impact.

Table 8

The two aspects of the impact from development, change from baseline activity and percent of total impact, are represented graphically in Figures 10 and 11. These show the change in each economic indicator over time and begin to represent the dynamic character of what may happen to the local economy as a result of this postulated copper-nickel development. Again the effects of the construction phase of the project are not presented here.

Figure 10 shows the estimated impact on each economic sector as a percent change from its projected baseline level of activity. They show that, in general, the impacts of development on gross output peaks in about the year 1995 (when opera-

Table 8. Rank of the economic sectors of the Study Area in terms of the projected percent of total impact.

RANK	GROSS OUTPUT % OF TOTAL		EMPLOYMENT % OF TOTAL		EARNINGS % OF TOTAL	
1	Trade	(8.5)	Services	(27.3)	Government	(21.5)
2	Services	(7.1)	Trade	(21.5)	Services	(18.7)
3	Manufacturing	(6.2)	Government	(18.0)	Trade	(12.5)
4	Government	(4.4)	Manufacturing	(6.4)	Manufacturing	(5.4)
5	Transportation	(1.7)	Transportation	(1.4)	Construction	(2.8)
6	Construction	(1.4)	Construction	(1.1)	Transportation	(2.5)
7	F,I,RE[a]	(1.3)	Other Industry	(0.5)	Other Industry	(0.5)
8	Utilities	(1.1)	F,I,RE[a]	(0.4)	F,I,RE[a]	(0.5)
9	Other Industry	(0.5)	Utilities	(0.2)	Utilities	(0.3)
10	Communication	(0.1)	Communication	(0)	Communication	(0.2)
11	Iron Mining	(0)	Iron Mining	(0)	Iron Mining	(0.1)
12	Agriculture	(0)	Agriculture	(0)	Agriculture	(0)

SOURCE: SIMLAB output.
[a] Finance, Insurance, Real Estate (F,I, RE)

tion starts in 1986). Impact on employment generally peaks at about the same time and it is difficult to generalize about the impacts on earnings.

Figure 10

Figures 11 and 12 present the impacts of development in terms of each sector's portion of the total change in each of the indicators.

Figures 11 and 12

15.7.5 Copper-Nickel Development Impact on Region III

Not all of the impact of copper-nickel development will occur within the Copper-Nickel Study Area. Because of such leakages as employee commuting from outside the Study Area and copper-nickel expenditures outside the Study Area, the effects of development will "spill over" to the larger regional level (Minnesota Development Region III plus Douglas County, Wisconsin). This is true of the direct as well as the indirect effects of development. In addition, facilities such as the smelter and/or refineries could be located outside of the Study Area.

The spill over impact is, however, relatively small if all facilities are located in the Study Area. Two factors are primarily responsible for this. First, the employee population of copper-nickel development is expected to be relatively concentrated around the site of the operation (Volume 5-Chapter 7, Residential Settlement Patterns). In addition, the Study Area includes the major business and population center on the eastern Iron Range - Virginia. Virginia is the probable area of major indirect business and residential growth, simply because it has the existing population base and business infrastructure to support additional growth. A second important factor is the concentration of taconite

FIGURE 10

COPPER-NICKEL DEVELOPMENT IMPACT ON STUDY AREA ECONOMY. OPEN PIT SCENARIO - PERCENT CHANGE FROM BASELINE.

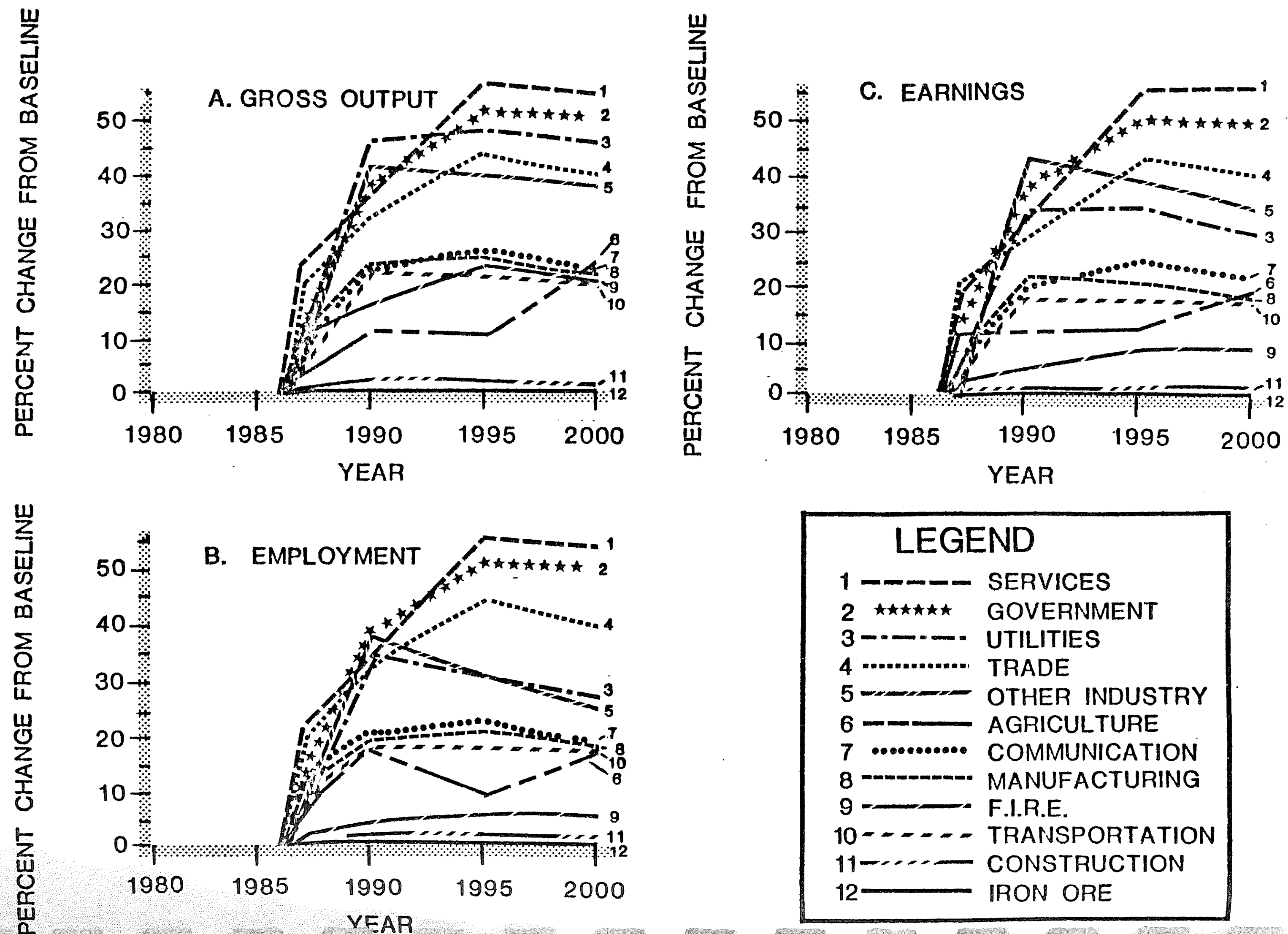
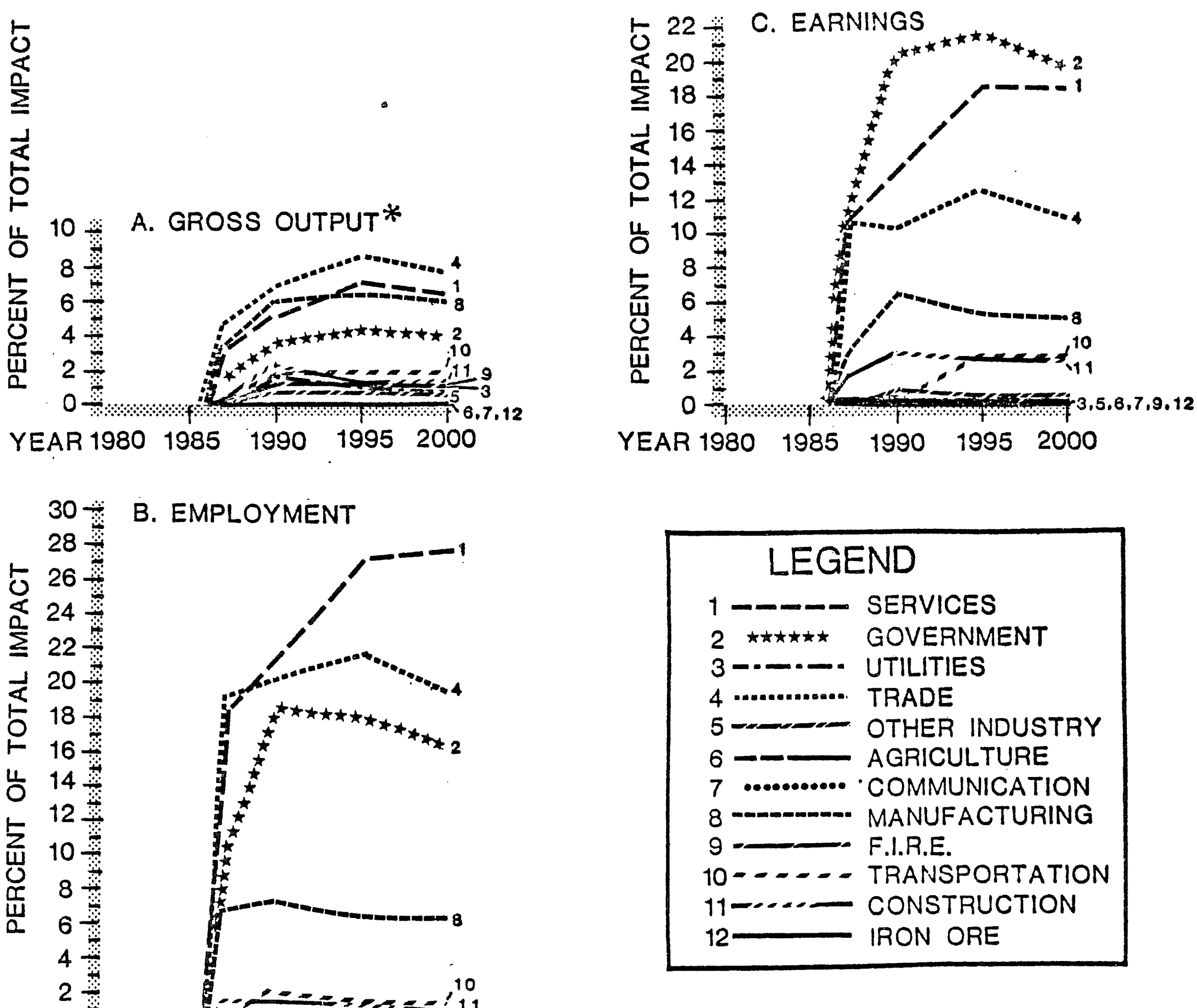


FIGURE 11

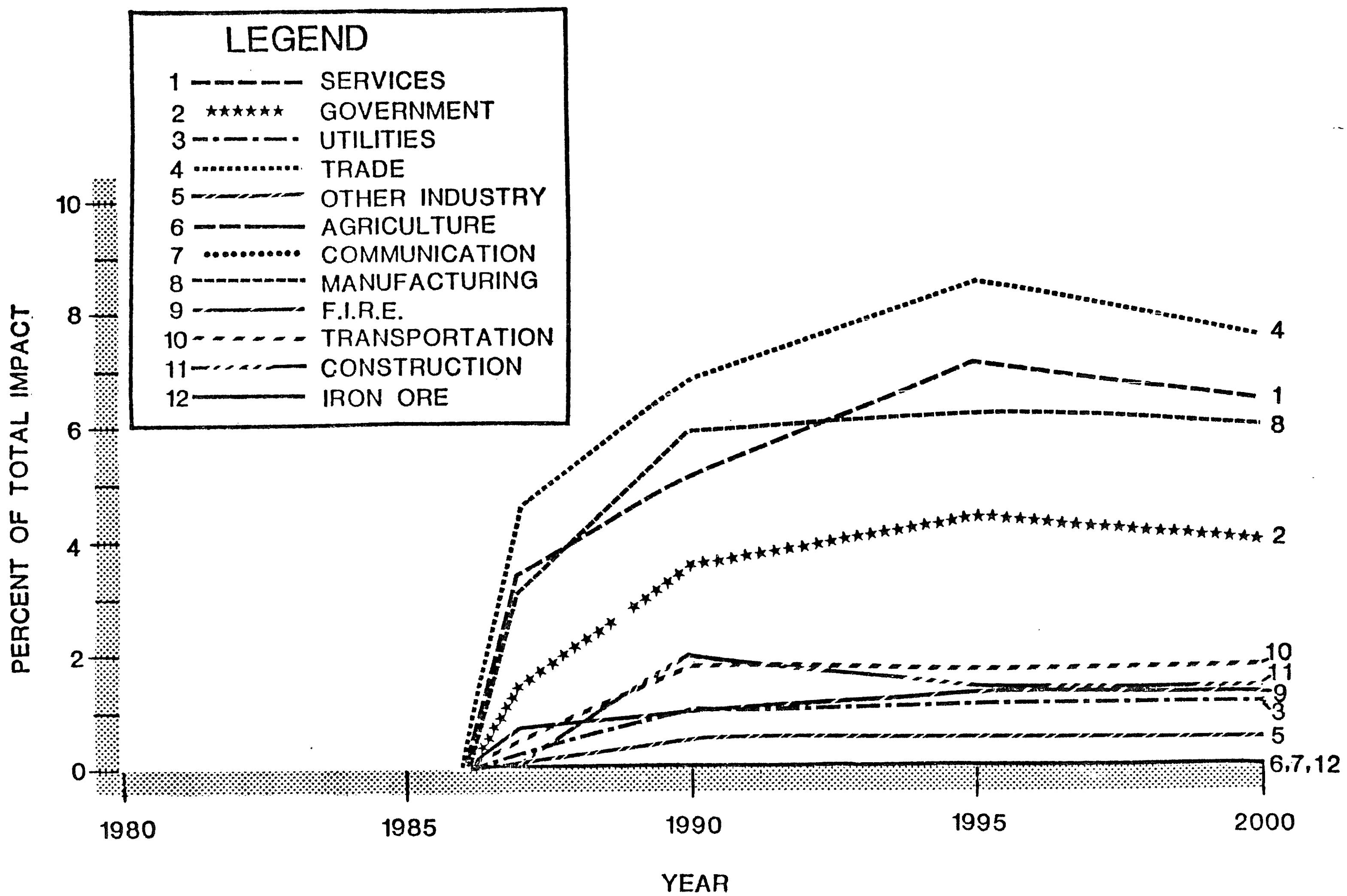
COPPER-NICKEL DEVELOPMENT IMPACT ON STUDY AREA INDUSTRIES. OPEN PIT SCENARIO - PERCENT OF TOTAL IMPACT



*FOR ENLARGED VIEW SEE FIGURE 12

FIGURE 12

COPPER-NICKEL IMPACT ON STUDY AREA GROSS OUTPUT
- OPEN PIT SCENARIO -



service industries already established in the Study Area. While not exactly alike, the taconite and copper-nickel mine and mill processes are very similar and the network of service and dealer enterprises existing in the Study Area will certainly adapt to some specialized copper-nickel demands.

Table 9 compares the impacts of the open pit scenario on three economic indicators for both the Study Area and the Region. Two important points are highlighted by the data. The table shows that the spill over impacts or leakages, are reduced over the life of the operation. This reflects the dynamic nature of the supporting industries within the Study Area and probably reflects the tendency for employees to gravitate over time toward the place of work. These factors will allow the Study Area to capture a larger portion of the total impact and this is reflected in the projections of each of the indictors. [A note about the data is necessary. Table 9 shows that the total Study Area impact is in some cases (late in the life of the operation) greater than the impact for the region. This is not possible and indicates some modeling error. Errors can occur in a myriad of places and forms and these account for the situation shown in the table. The important point is that the magnitude of the impact converges over time for the two areas.]

Table 9

A second major point shown in the table is the larger leakages seen in employment, especially during the early stages of development. This reflects that a greater portion of output and earnings will be captured in the Study Area and more support industry employment opportunities will be found throughout the region. This is due in part to the breakdown of direct and indirect impact for each of these indicators. The indirect employment generated from development is

Table 9. Total impact of the open pit scenario on three economic indicators, Study Area and Region III.

	STUDY AREA IMPACT	REGIONAL IMPACT	STUDY AREA IMPACT AS A PERCENT OF REGION IMPACT
Gross Output[a] ($ million)			
1987	331.1	365.7	90.5
1990	394.6	397.0	99.1
1995	422.5	426.6	99.0
2000	409.9	408.2	100.4
Employment			
1987	5,048	6,767	74.6
1990	7,803	8,367	93.3
1995	9,006	9,446	95.3
2000	7,645	7,887	96.9
Earnings[a] ($ million)			
1987	45.6	54.1	84.3
1990	71.7	72.1	99.4
1995	86.7	85.1	101.9
2000	82.6	82.0	100.7

[a] $1970.

projected to be a much larger portion of the total than will be the direct employment. This is not true for output and earnings which are much more evenly balanced with regard to direct and indirect impacts. The large number of indirect jobs created by development will more than likely result in leakages from the Study Area.

During the construction phase of the development spillover impact should be large. In fact, the impact may extend beyond the regional boundaries to state and national influence. Construction firms headquarted outside the Study Area will be required for the magnitude and type of construction necessary for the integrated copper-nickel operation. This will "siphon off" some of the economic impacts from the local area. Construction workers with permanent residences outside the area will return a large portion of the construction payroll to their respective home areas, thus minimizing the multiplier effects of development.