# REGIONAL IMPACTS OF COAL MINING
# IN EASTERN OKLAHOMA

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TABLE OF CONTENTS

| Chapter | | Page |
|---|---|---|

LIST OF TABLES

## LIST OF FIGURES

# CHAPTER I

# INTRODUCTION

## General Problem

The political and economic consequences of being dependent upon foreign oil producers have been exposed by the 1973 Arab oil embargo, the 1979-80 Iranian oil disruptions and hostage crises. America's dependence upon foreign energy supplies has aggravated its balance of payments and inflation problems, while contributing to slow economic growth and waning international power. These issues have caused U.S. policy makers to propose and enact national energy programs to conserve and develop alternative energy sources to reduce in the short run, and eliminate in the long run the United States' dependence upon foreign oil supplies.

During the period 1973-83, the amount of energy consumed in the United States grew each year except for two periods. First, consumption decreased in 1974 and 1975 following the Arab oil embargo. Energy consumption reached a record high in 1979, when the amount of energy consumed was 78.91 quadrillion ($10^{15}$) British thermal units (Btu). Subsequently, energy consumption has declined. In 1983, U.S. energy consumption totaled 69.54 quadrillion Btu. This figure is 6.8, 11.9, and 2.1 percent smaller than the amounts of energy consumed in the years 1973, 1979, and 1982, respectively (1).

The 1973 Arab oil embargo had two lasting effects. First, energy consumption patterns have changed. In 1973, petroleum, natural gas, coal and other energy sources accounted for 46.7, 30.2, 17.9, and 5.3 percent of the total energy consumed, while in 1983 their shares were 43.0, 24.1, 22.8, and 10.1 percent, respectively. This situation indicates that energy demand is shifting to coal and other energy sources, such as hydroelectric, nuclear and geothermal power (1). Between 1973 and 1983, coal consumption on a British thermal unit basis increased by 19 percent, reaching a record high 15.973 quadrillion Btu in 1981.

Second, energy production sources have been modified to reflect changes in energy consumption patterns. Between 1973 and 1978, coal production on a Btu basis increased by 10.2 percent, decreased by 5 percent in 1978 and grew 6.3 percent from 1979 to 1982. However, it declined to 17.567 quadrillion Btu in 1983. This decline in energy production was associated with the recession which began in 1981. Coal production contributed 23.0 and 28.8 percent to total energy production in 1973 and 1983, respectively. Petroleum and natural gas shares of total energy produced declined from 31.2 and 35.5 percent in 1973 to 30.0 and 26.2 percent in 1983, respectively.

Given the organization of our economy, oil products and natural gas are such generally used and convenient commodities that we have great difficulty in reducing their use through short-term rising prices and long-term national conservation policies. If we look at possible demand for oil and gas in 1995 in terms of world requirements and sources, it becomes clear that the United States may become more dependent on imported oil over the next 15 years (2). However, the

United States has a very large reserve base of coal. This reserve was estimated to be 482.9 billion tons in 1982; 156.9 billion tons can be recovered by surface mining, and 324.9 billion tons are accessible by underground mining (3).

These coal resources are being evaluated as one of the major sources for meeting the nation's energy needs. However, the mining, transportation, and burning of coal may cause environmental problems. Moreover, rapid development of coal mining operations and huge coal-burning electric power plants are likely to result in rapid economic and population growth in areas with very small population and service bases and a history of stable or declining population. Thus, coal development may result in massive economic and social changes in areas near extraction and conversion sites. Also, communities along transportation routes may experience substantial effects.

The economic, demographic, and social effects of large scale industrial and resource development projects are a subject of growing concern to managers and decision makers in both private and public sectors. The rapid population growth and associated public service and social problems resulting from energy resources development in rural areas of the United States have demonstrated the need for more effective means of mitigating such impacts (4, 5).

Oklahoma's demonstrated reserve base of coal was estimated to be 1.6 billion short tons in 1982, of which 75 percent can be recovered by underground mining, while 25 percent is available for recovery by surface mining (3). Even though this reserve base comprises only 0.4 percent of the Nation's demonstrated reserve base, it represents a potential source of energy during a period of increasing concern for development of domestic energy supplies. Development of this coal reserve offers job opportunities in areas of Oklahoma where unemployment and underemployment are high (6).

## Specific Problem

Oklahoma cannot be isolated from the United States energy situation. Like the economies of all other states, it depends on the use of vast amounts of energy. In 1973, Oklahoma's energy consumption was 1,000.2 trillion Btu, of which 0.4, 58.7, 37.2, and 3.7 percent were produced by coal, natural gas, petroleum, and hydroelectric power, respectively. The energy consumption increased by 25.8 percent between 1973 and 1981. However, the consumption energy patterns have changed during this period. Energy demand has shifted to coal. Coal consumption on a Btu basis increased by 3,133 percent between 1973 and 1981; in 1981 it contributed 11.8 percent to total energy consumption (7).

Coal is mainly used to produce electricity. In 1977, 2.0 percent of the net electricity generated in Oklahoma was produced by coal and 91.5 percent was generated by natural gas. However, coal contribution has been steadily increasing to contribute 42.8 percent to net electricity generation in 1983 (8, 9). The shift to coal and its large increase as an energy source is very much due to the 1974 Energy Supply and Environmental Coordination Act, the 1978 National Energy Conservation Policy Act, the 1978 Powerplant and Industrial Fuel Use Act, and the 1978 Natural Gas Policy Act.

Oklahoma's coal-fired electric power plants at the present time are not using Oklahoma coal. They use low-sulfur (0.4-0.7 percent) coal from Wyoming to meet the state air quality standards which allow 1.2 pounds of $SO_2$ missions per million Btu of fuel. However, this coal has a lower Btu value (8,300 Btu) per pound and more moisture (30 percent) than does Oklahoma coal. Use of Oklahoma coal in these electric power plants would require either lowering air pollution standards, installing the technology for trapping the sulfur, or blending Oklahoma and Wyoming coal. Many factors affect the decisions of those electric power plants to use Wyoming coal. It is necessary to determine what those factors are and what changes are needed in the existing coal-fired electric power plants, or in the technology used, or in the state air quality standards for those plants to be able to use a mixture of Oklahoma and Wyoming coal.

Use of a blend of 10 percent Oklahoma coal in the generation operation of these coal-fired electric power and a recovery of the United States economy will cause an expansion in the Oklahoma coal industry. Expanding coal development will affect the economic, demographic, public service, fiscal, social, environmental, and other characteristics of the Oklahoma rural areas. Some of these effects may be generally regarded as positive, while others may be considered negative; in some cases, the same changes in community characteristics may be seen as favorable by some and adverse by others.

Among the many socioeconomic effects of energy development, some of the most important are: 1) employment, 2) income, 3) business activities, 4) population growth, 5) population distribution, 6) population characteristics, 7) requirements for public service, including police, fire, medical, social, and other services, 8) public sector revenues and expenditures, and 9) community residents' perceptions and attitudes. The effects on these socioeconomic dimensions concern both public and private decision makers in formulating investment decisions and are of critical importance in determining the overall costs and benefits of such development to the areas where they are undertaken.

Extensive analysis of socioeconomic impacts and impact assessment methods have been completed. However, the general state of knowledge concerning such effects is limited. Previous analyses typically have been concerned only with the short-term effects associated with energy development projects and have seldom treated their long-term effects. As a result, these studies generally lacked the ability to address the effects of development over its various stages. These difficulties may be overcome by addressing the full range of impacts which are likely to occur over time.

Another limitation of the current state of knowledge is that little definitive information is available concerning regional variations in socioeconomic impacts. Examples drawn from western energy development areas may not be applicable to Oklahoma. Information from retrospective case studies of projects developed in different regional contexts is needed to anticipate more accurately and timely the effects of future energy development projects that may be undertaken in a given area (e.g., Eastern Oklahoma mining region) and to enable decision makers to manage such impacts more effectively.

## Objectives of the Study

The overall objective of the study is to identify the role of an expansion of the Oklahoma coal mining industry in promoting economic growth in a predominantly rural and economically depressed region located in the eastern part of the state. Specific objectives of the study are to:

1. Estimate the economic impacts of the coal mining industry on the entire state economy,
2. Determine impacts on major industries that provide intermediate inputs to the coal mining industry,
3. Estimate commuting patterns of the coal mining workers
4. Examine the economic, social, and environmental well-being impacts of coal mining and reclamation in the study area,
5. Determine some of the factors that prevent Oklahoma coal-fired electric power plants from using state coal in their generation operations, as well as conditions that may increase the demand for Oklahoma coal.

## Study Area

Oklahoma's coalbeds are part of the Western region of the Interior coal province of the United States (10). These coalbeds are located in 19 counties in northeastern and southeastern Oklahoma (Figure 1). This study focuses on only 12 counties which contain 96 percent of the remaining bituminous coal resources in Oklahoma. Henceforth, the term "Coal Region" will refer to the study area, which encompasses Coal, Craig, Haskell, Latimer, LeFlore, McIntosh, Muskogee, Nowata, Okmulgee, Pittsburg, Rogers, and Wagoner Counties. These counties were selected because they offer the major potential for coal mining based on their reserves, coal seam, coal depth, sulfur

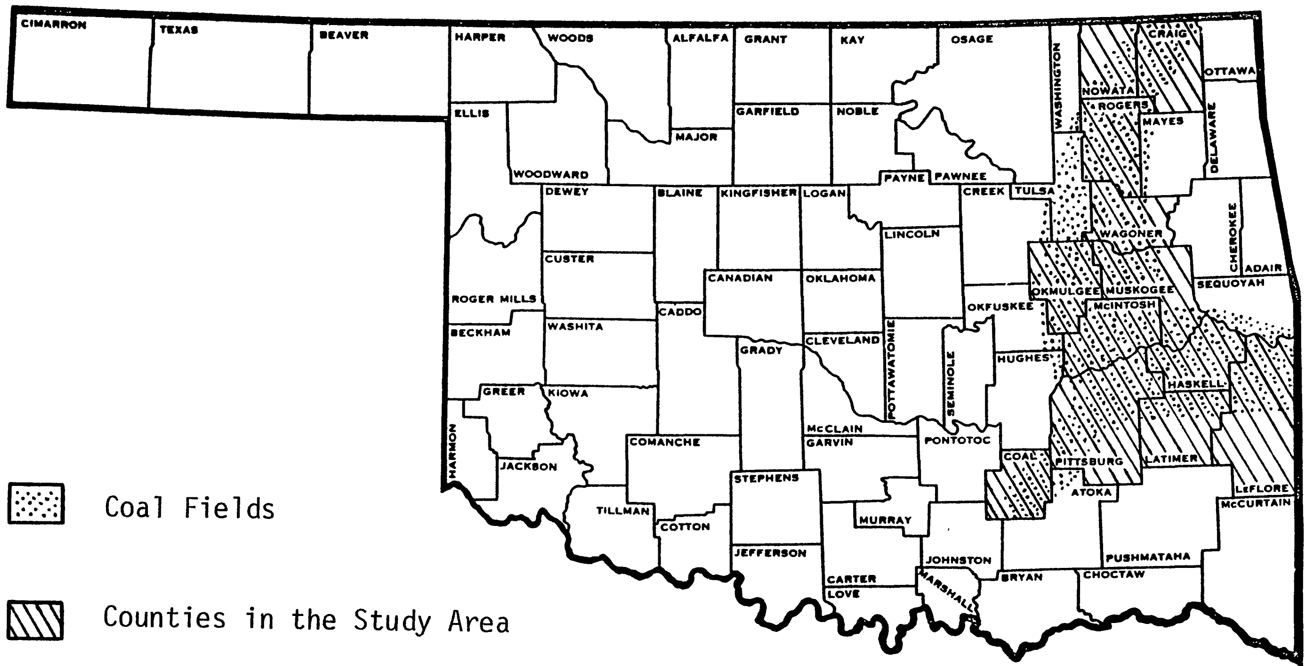


Figure 1. Study Area and Coal Fields of Oklahoma

content, ash content, and British thermal unit (Btu) requirements and because they currently have greatly depressed economies and have the potential for significant employment, and other economic and environmental impacts from coal mining.

The Coal Region contains about 7.5 billion short tons of the remaining coal resources in Oklahoma (Table I). The counties which have most of these resources are: LeFlore (25.4 percent), Haskell (19.5 percent), Pittsburg (17.8 percent), Latimer (10.8 percent), Craig (8.4 percent), and Okmulgee (4.8 percent).

Between 1976 and 1983, most of the coal was produced by the counties in the Coal Region. The Oklahoma production of coal by counties, as well as the percentage produced by each county for the period 1976-1983 are presented in Table II. In 1976, 1980, 1981, and 1983 all coal production took place in the Coal Region. In 1977, 1978, 1979, and 1982 a very small percentage (0.1-1.2 percent) was produced by the remaining coal counties.

In 1976 the major coal producers were Craig and Rogers Counties which accounted for 58.6 and 13.6 percent, respectively, of the coal produced in that year. During the period 1976-1983, the production share of Craig County declined as those of the other counties in the Coal Region increased. In 1973, each of the Coal Region Counties, with the exception of Coal and Pittsburg Counties, produced more than 5 percent of the total coal production of Oklahoma.

## Organization of the Thesis

This thesis is organized into eight chapters. A review of literature related to the study is presented in Chapter II. The basic

TABLE I

REMAINING BITUMINOUS COAL RESOURCES IN OKLAHOMA
BY COUNTY, JANUARY 1, 1979

| Counties | Thousands of Short Tons | Percent |
|---|---|---|
| Coal Region | | |
| Coal | 292,875 | 3.77 |
| Craig | 654,500 | 8.42 |
| Haskell | 1,513,681 | 19.47 |
| Latimer | 841,968 | 10.83 |
| LeFlore | 1,973,362 | 25.38 |
| McIntosh | 46,755 | 0.60 |
| Muskogee | 61,199 | 0.79 |
| Nowata | 30,080 | 0.39 |
| Okmulgee | 370,695 | 4.77 |
| Pittsburg | 1,383,833 | 17.80 |
| Rogers | 243,906 | 3.14 |
| Wagoner | 63,541 | 0.82 |
| Subtotal | 7,476,395 | 96.18 |
| Other Counties | | |
| Atoka | 29,619 | 0.38 |
| Creek | 14,046 | 0.18 |
| Mayes | 4,004 | 0.05 |
| Okfuskee | 79,351 | 1.02 |
| Sequoyah | 27,146 | 0.35 |
| Tulsa | 138,397 | 1.78 |
| Washington | 4,655 | 0.06 |
| Subtotal | 297,218 | 3.82 |
| TOTAL | 7,773,613 | 100.00 |

Source: (11)

TABLE II

PRODUCTION OF COAL IN OKLAHOMA BY COUNTY AND YEAR, 1976-1983

| Counties | 1976 Tons | 1976 % | 1977 Tons | 1977 % | 1978 Tons | 1978 % |
|---|---|---|---|---|---|---|
| Coal Region | | | | | | |
| Coal | -- | -- | -- | -- | -- | -- |
| Craig | 2,124,267 | 58.6 | 2,546,583 | 47.6 | 2,268,655 | 41.8 |
| Haskell | 214,245 | 5.9 | 445,791 | 8.3 | 393,324 | 7.2 |
| Latimer | 32,187 | 0.9 | 234,271 | 4.4 | 340,288 | 6.3 |
| LeFlore | 244,205 | 6.7 | 266,699 | 5.0 | 168,633 | 3.1 |
| McIntosh | -- | -- | 25,416 | 0.5 | 25,492 | 0.5 |
| Muskogee | 96,184 | 2.7 | 117,298 | 2.2 | 136,177 | 2.6 |
| Nowata | 101,301 | 2.8 | 262,064 | 4.9 | 143,079 | 2.6 |
| Okmulgee | 219,732 | 6.1 | 375,899 | 7.0 | 457,595 | 8.4 |
| Pittsburg | 42,323 | 1.2 | -- | -- | 19,500 | 0.4 |
| Rogers | 492,414 | 13.6 | 840,558 | 15.7 | 1,051,082 | 19.4 |
| Wagoner | 59,923 | 1.7 | 214,635 | 4.0 | 359,981 | 6.6 |
| Subtotal | 3,626,781 | 100.0 | 5,329,214 | 99.7 | 5,363,806 | 98.8 |
| Other Counties | | | | | | |
| Atoka | -- | -- | -- | -- | -- | -- |
| Creek | -- | -- | -- | -- | -- | -- |
| Mayes | -- | -- | 17,400 | 0.3 | -- | -- |
| Okfuskee | -- | -- | -- | -- | -- | -- |
| Sequoyah | -- | -- | -- | -- | 8,988 | 0.2 |
| Tulsa | -- | -- | -- | -- | 55,944 | 1.0 |
| Washington | -- | -- | -- | -- | -- | -- |
| Subtotal | -- | -- | 17,440 | 0.3 | 64,932 | 1.2 |
| TOTAL | 3,626,781 | 100.0 | 5,346,654 | 100.0 | 5,428,738 | 100.0 |

TABLE II (Continued)

| Counties | 1979 Tons | 1979 % | 1980 Tons | 1980 % | 1981 Tons | 1981 % |
|---|---|---|---|---|---|---|
| Coal Region | | | | | | |
| Coal | -- | -- | -- | -- | -- | -- |
| Craig | 1,072,922 | 35.5 | 1,804,546 | 33.6 | 1,513,354 | 26.4 |
| Haskell | 558,581 | 11.7 | 700,876 | 13.1 | 577,465 | 10.1 |
| Latimer | 224,168 | 4.7 | 252,911 | 4.7 | 241,997 | 4.2 |
| LeFlore | 224,644 | 4.7 | 302,618 | 5.6 | 539,484 | 9.4 |
| McIntosh | 56,618 | 1.2 | 10,993 | 0.2 | 71,399 | 1.2 |
| Muskogee | 124,814 | 2.6 | 247,254 | 4.6 | 363,653 | 6.3 |
| Nowata | 47,713 | 1.0 | 23,019 | 0.4 | 177,520 | 3.1 |
| Okmulgee | 330,521 | 6.9 | 589,957 | 11.0 | 415,153 | 7.2 |
| Pittsburg | 57,458 | 1.2 | 80,200 | 1.5 | -- | -- |
| Rogers | 1,004,054 | 21.0 | 1,098,854 | 20.5 | 1,464,017 | 25.6 |
| Wagoner | 418,567 | 8.7 | 252,458 | 4.7 | 364,419 | 6.4 |
| Subtotal | 4,750,060 | 99.1 | 5,363,714 | 100.0 | 5,728,461 | 100.0 |
| Other Counties | | | | | | |
| Atoka | -- | -- | -- | -- | -- | -- |
| Creek | -- | -- | -- | -- | -- | -- |
| Mayes | -- | -- | -- | -- | -- | -- |
| Okfuskee | -- | -- | -- | -- | -- | -- |
| Sequoyah | -- | -- | -- | -- | -- | -- |
| Tulsa | 41,707 | 0.9 | -- | -- | -- | -- |
| Washington | -- | -- | -- | -- | -- | -- |
| Subtotal | 41,707 | 0.9 | -- | -- | -- | -- |
| TOTAL | 4,791,767 | 100.0 | 5,363,714 | 100.0 | 5,728,461 | 100.0 |

TABLE II (Continued)

| Counties | 1982 Tons | 1982 % | 1983 Tons | 1983 % |
|---|---|---|---|---|
| Coal Region | | | | |
| Coal | -- | -- | 47,482 | 1.3 |
| Craig | 983,854 | 21.2 | 841,372 | 23.1 |
| Haskell | 484,949 | 10.4 | 354,510 | 9.8 |
| Latimer | 263,738 | 5.7 | 190,292 | 5.2 |
| LeFlore | 640,719 | 13.8 | 427,894 | 11.8 |
| McIntosh | 144,616 | 3.1 | 244,974 | 6.7 |
| Muskogee | 252,284 | 5.4 | 218,148 | 6.0 |
| Nowata | 116,993 | 2.5 | -- | -- |
| Okmulgee | 323,710 | 7.0 | 204,841 | 5.6 |
| Pittsburg | -- | -- | 25,890 | 0.7 |
| Rogers | 1,120,701 | 24.1 | 649,353 | 17.9 |
| Wagoner | 311,949 | 6.7 | 431,134 | 11.9 |
| Subtotal | 4,643,513 | 99.9 | 3,635,890 | 100.0 |
| Other Counties | | | | |
| Atoka | 2,439 | 0.1 | -- | -- |
| Creek | -- | -- | -- | -- |
| Mayes | -- | -- | -- | -- |
| Okfuskee | -- | -- | -- | -- |
| Sequoyah | -- | -- | -- | -- |
| Tulsa | -- | -- | -- | -- |
| Washington | -- | -- | -- | -- |
| Subtotal | 2,439 | 0.1 | -- | -- |
| TOTAL | 4,645,952 | 100.0 | 3,635,890 | 100.0 |

Source: (12)

concepts of the analytical tools and the methodology used in the study are discussed in Chapter III. A discussion of the fluctuating conditions and problems of the Coal Region economy is included in Chapter IV. The results and discussion of the input-output analysis, as well as some other economic impacts related to coal mining in the study area are presented in Chapter V. The analysis of economic, social, and environmental well-being impacts of coal mining and reclamation in the study area are being presented in Chapter VI. The results of the surveys for superintendents of coal-fired electric power plants, as well as the discussion of some conditions that may induce those plants to use Oklahoma coal are contained in Chapter VII. Finally, the summary, conclusions, and recommendations for future research are presented in Chapter VIII.

## CHAPTER II

## REVIEW OF LITERATURE

### Socioeconomic Effects of Coal Development

Accelerated coal development in the western United States has caused increases in employment, income, population, and community development in predominantly rural areas over the last decade. These effects, in turn, have produced some changes in lifestyles and social structures and have sometimes caused problems in meeting growth related needs. Coal development in these communities has been a mixed blessing with both favorable and unfavorable effects on the communities' human environment. Such effects are usually called "socioeconomic impacts".

In this section, a brief review of literature related to the economic, demographic, and social effects of energy development, particularly coal development, is presented. In discussing these impacts, it is important to note that the specific implications of energy development for the human environment are a function of the interrelationship between the characteristics of the proposed development project and the characteristics of the area prior to the initiation of the project (13).

Employment characteristics, location, and length of the construction and operational phases of the project are the key characteristics in the determination of the levels of socioeconomic impacts caused by the project. These impacts are mostly determined by the size of the labor force involved in the construction and operation of the facility. Usually, larger labor forces mean larger service demands, higher public costs and larger social impacts. However, the location of the facility may considerably affect those impacts, e.g., the impacts of a new plant are likely to be greater in sparsely settled areas than in large urban centers with well-developed infrastructures (14).

Leistritz and Murdock (15) contend that the impacts of most energy-related developments are cyclical. They are greater during construction periods, reduce markedly from construction to operation periods and decrease even more dramatically when the operational life of the project has ended.

The characteristics of the site prior to the beginning of the development project may either mitigate or strengthen impacts. Thus, the service impacts are likely to be lessened if the availability of local labor is high and community services have significant excess capacity. However, service demands will be severely impacted when local labor availability is low and services are already overloaded because the number of immigrants will be greater (14).

## Economic Impacts

As the construction and operation phases of energy development projects start, workers are hired from the local area, from other areas within the region, and from outside the region. Murdock and Leistritz (16) examined the characteristics of energy related workers in the Great Plains states and concluded that substantial differences exist between construction workers and permanent operating and maintenance workers and that local hiring depends on the availability of local workers and whether they possess the skills required for the construction or operation of the facility.

Studies conducted by researchers of Mountain West Research, Inc. (17) revealed that construction workers are mainly craftsmen with highly specialized skills who are geographically mobile in response to new job opportunities, that they earn high wages and that they are employed temporarily. They also concluded that about 40 percent of the total work force of 14 construction sites was made up by local workers who were mostly employed in the less skilled job categories.

Wieland, Leistritz, and Murdock (18) conducted a survey of workers at 14 coal mines and power plants in Montana, North Dakota, South Dakota and Wyoming. They found out that mine and power plant operation required large numbers of technicians, heavy equipment operators and mechanics whose wages were usually higher than those paid in other jobs in rural areas. They also determined that local workers made up 62 percent of the mine and power plant operation work forces and that only two of those 14 sites had less than 50 percent local workers.

Little and Lovejoy (19) administered an extensive open-ended interview schedule to 248 household heads in Kanab and Escalant, Utah; and Page, Arizona to examine the validity of the argument that local communities in the energy-rich Rocky Mountain and Northern Great Plains states will achieve drastic employment gains from rural energy development projects. They concluded that large numbers of jobs for locals were simply unlikely to materialize, and those that did were probably in the less skilled and lower paying categories. They also found out that relatively few people were willing to be trained if they were not paid a wage during this training period and that even unemployed persons tended to reject the possibility of being trained to gain employment at the development project sites. Furthermore, their projections indicate that fewer than one percent of the approximately 4,000 new primary jobs to be created by such energy development projects were likely to be filled by local residents.

Leistritz and Maki (20) evaluated the impacts of selected coal mines and coal-fired power plants in McLean, Mercer, and Oliver Counties, North Dakota. They concluded that construction and operation of these facilities have had a significant effect on employment, income, and population in the multi-county region surrounding the sites. They found out that the combined construction work force for such facilities ranged from 1,839 to 4,620 during the period 1977-1979 and that the operation and maintenance work force would total 1,250 in the mid-1980's.

The construction and operation of a coal related facility can be expected to stimulate increased economic activity and to generate additional employment in various trade and service sectors of the local economy. This employment type is often called indirect or service employment. Analyses conducted by Murphy and Williams, consultants (21), suggest that indirect employment resulting from an energy project may exceed direct employment by a factor of approximately 1.5 to one.

The employment effects of a coal development project are reflected in income effects. Leistritz and Maki (20) evaluated the income impacts of coal developments in the Coal Creek Station area in

North Dakota. They found out that personal income and per capita personal income for the study area increased by about 117 and 93 percent, respectively, between 1970 and 1977.

Higher local incomes and population growth associated with energy development projects may cause consumer price increases, which are the results of increased demands for many goods and services. Studies conducted by Leistritz and Maki (20) revealed that higher prices for locally purchased goods and services was a problem of concern to local leaders. Gilmore and Duff (22) have contended that housing costs are particularly responsive to price increases and that they increased rapidly during periods of energy related growth. Nevertheless, Thompson (23) conducting a longitudinal study for the Old West Region Commission found inconclusive price effects in two impact cases in Wyoming and North Dakota contrasted with similar nonimpact areas in Montana and Nebraska.

Demographic Impacts

The amount and timing of population increase in communities and counties affected by coal-related developments are critical pieces of information for local planners and decision makers. Leistritz and Murdock (14) argue that the magnitude of growth may be largely relative to the size of the existing communities. Thus, the total population change resulting from a given coal development project may double or triple the size of the small communities within the impacted area.

Leistritz and Maki (20) evaluated the population effects caused by the construction of the Coal Creek electrical generating station and associated coal mines in North Dakota. They found out that these developments led to substantial population growth in several McLean County communities. Thus, the county's population increased 9.2 percent between 1970 and 1980, while Washburn's and Underwood's populations increased 120 and 70 percent, respectively, during the same period.

They also determined that a modest population decline took place at the end of the construction period of such facility; however, the decline was lower than expected. This phenomenon was attributed to the influx of population associated with the buildup of the permanent work force, which may have offset a significant part of the outmigration of the construction workers and their dependents, and to the fact that a substantial part of the Coal Creek construction work force may have remained in McLean County and obtained employment at power plant construction sites in Mercer County, North Dakota.

Studies conducted by Myers (24) indicated that increased coal production contributed to population expansion in the major coal counties of the Interior and Western Regions of the United States, but not in the Eastern Region. Major coal-producing counties of the Interior and the Western Regions experienced annual population growth rates of 1.7 and 5.5 percent, respectively, during the period 1973-1979.

Leistritz and Murdock (14) have indicated that the demographic effects of an energy development project are the results of its employment impacts and the subsequent migration of workers and their families into the impact area. Thus, they argue that the magnitude of population growth related with a project depends on the size of the direct work force, the magnitude of indirect employment effects, the degree to which employment requirements are satisfied by the local labor force through increased utilization of unemployed and underemployed workers and through increased labor force participation of the local population, the average number of dependents related with in-migrating workers and their settlement-commuting patterns.

Impacts on Agriculture and Other Basic Industries

Expanded development of energy resources may cause competition between the energy industry and other basic industries for scarce resources. The impact on other basic industries will depend upon the amount of the resource being mined and the uses to which it is put. The effects of coal development on agriculture may be the result of competition for the use of land, water and labor (25, 26).

Analyses conducted by McMartin (27) and Whittlesey (28) indicate that the effects of energy developments on agricultural production will be minimal. Compared with the nation's vast area of cropland and ranges, relatively little farmland will be disturbed by increased surface mining of coal. Analysts (29) estimated that during the average year, only 568,000 acres will be unavailable for other uses because of mining and reclamation activities on strip-mined land. This acreage only represents a tiny fraction of the Nation's 2.25 billion acres of land. They also indicated that farm production losses might amount to about $16 million a year, which is not a serious threat to food supplies from either a national or regional perspective. However, Callahan and Callahan (30) studying the socioeconomic impacts of strip mining of coal on communities and natural resources contend that as strip mining increases, land use is shifted from more intensive to less intensive uses.

Juers, Leistritz, Olson, Osterhoudt, Stroup, and Voelker (31) analyzed the effects of energy development on agricultural and rural communities in the western United States. They concluded that the impact on some individual farms and ranches may be severe and that some of these units may have to make drastic adjustments or go out of existence if a high percentage of their land is taken away by energy industries during a short period of time.

The water requirements for strip mining and coal preparation for shipment are nominal. Water is used mainly to control dust on haul and access roads (32). However, significant water quantities may be needed for irrigation during the land reclamation process, especially in years of low precipitation and for electric power generation or conversion of coal to other forms of fuel. Also, the increased population resulting from expansion of the coal industry in sparsely-settled areas will need large additional supplies of water for domestic use and municipal water systems.

Dobson (33) conducted a nationwide assessment of water quantity impacts by the National Energy Plan. He concluded that by 1985 the aggregate impact of all projected energy development, including coal, will increase water use by less than one percent of the United States water supply. However, this assessment tended to disguise critical regional problems. The Yellowstone River Basin (Montana and Wyoming), the Upper Colorado Basin (Colorado and Wyoming), and the North Platte Basin (Colorado, Nebraska, and Wyoming) are regions with scarce water supplies. Thus, added competition for water from coal development could become a serious problem in those areas (29).

Scott and Chen (34) analyzed the expected changes in farm organization when an industry moves into a rural area. They have indicated that increased competition for labor caused by extensive coal development is likely to affect agriculture and local trade and service firms. Thus, farmers and ranchers operating large farms and ranches and hiring large amounts of labor may be forced to offer higher wages, reorganize their farms or both. However, this phenomenon is unlikely to occur in eastern Oklahoma where lack of jobs is a serious problem. Obiechina (35) and Ghebremedhin and Salkin (6), studying the impacts of the coal industry in Oklahoma found out that coal mining provided employment opportunities for unemployed and underemployed workers, including farmers and ranchers.

### Impacts on Community Services

Population growth associated with coal mining developments are expected to lead to increased demands on a variety of public services and facilities, including: 1) schools, 2) housing, 3) water and sewer, 4) public safety, 5) transportation, and 6) social services (20, 31). Gilmore and Duff (22) indicate that when such population growth takes place communities can experience serious growth management problems.

Studies conducted by Leholm, Leistritz, and Hertsgaard (36), Gilmore, Moore, Hammond, and Coddington (37), Murphy (38) and Austin, Capener, Catlett, Eastman, Gray, Ives, Matthews, Supalla, and Stevens (39) on the public service impacts of coal development show that significant capital costs are generally related with expanding schools and sewer and water systems, which may pose serious cash flow problems for local governments. These studies indicate that if the community does not have initial excess capacity in some of its public service infrastructure, it can be expected to undergo additional capital costs between $3,000 and $6,000 per capita for the in-migrating population and additional operating and maintenance costs of $400 to $600 per capita (in 1975 dollars). However, Obiechina (35) studying the economic and environmental impacts of coal mining and reclamation in eastern Oklahoma found out that coal mining development has not caused meaningful impacts on the public service sector of Rogers, Craig, Nowata, and Okmulgee Counties.

Gilmore and Duff (22) analyzed the effects of coal-related development on the Rock Springs area of Wyoming. They observed that as a consequence of a rapid population influx associated with the construction of a large coal-fired electric generating plant, the area has experienced a severe shortage of housing and of educational, health, and recreational services.

## Fiscal Impacts

The change that any energy development produces in the revenues and expenditures of local governmental units is an important aspect of the impacts of such development. Generally, revenues from the construction and operation of a coal development project surpass the costs of providing facilities and services for the population increases associated with the project. However, the timing of revenue collection in relation to service costs and the distribution of costs and revenues between jurisdictions may prevent revenues from arriving when and where they are needed (13).

Andrews, Murdock, and Jones (40) studied the private and public sector economies of lignite-energy resource development in the Brazos Valley, Texas. They found out that present values for net fiscal balance at the county level were positive for all counties within the area studied with the exception of Brazos County, which has no lignite projects located within its boundaries, but receives the major portion of project-related immigrants; thus it incurs costs associated with providing public services for this added population, while it receives minimal additions to its tax base. They also concluded that present values for net fiscal balance at the municipal level were negative for all municipalities considered with the exception of Navasota and that at the school district level such values were positive only for those districts which contained a taxable coal development project.

Dalsted, Leholm, Toman, Coon, Hertsgaard, and Leistritz (41) used an input-output model to assess the impacts of a large coal gasification plant in North Dakota. They concluded that at the state level revenues exceeded additional costs during the life of the plant. They also indicated the need to alleviate the fiscal burden of the small impacted local governments through the State Coal Impact Fund and Special Federal Impact Aid programs.

Social Impacts

Among the impacts of energy development most frequently exaggerated in the press and visible in levels of public concern are those including basic changes in the forms of interaction, in the value systems, and in the way of life in rural communities (16). The socioeconomic characteristics of new residents may affect their levels of participation in community activities and organizations. Problems of integration of those new residents into the community are likely to increase with the rate and magnitude of population growth. Also, the socioeconomic characteristics of such new residents will affect their perceptions of site area communities and the long-term residents' perceptions of them (42, 43, 44).

Gold (45) conducted a study of the impact of coal development on the way of life of people in coal areas of eastern Montana and northeastern Wyoming. He found out that the influx of large numbers of new residents has changed the informality and intimate nature of social interactions in rural areas and has led to decreasing informality of relationships and to increased formality in interaction patterns. He also concluded that immigrants and longtime residents were competing for informal leadership and status roles and that persons employed in the newly dominant coal industry have tended to replace earlier dominant groups.

Rapid population growth is frequently associated with significant increases in rates of crime, drug abuse, mental illness (46), divorce and other manifestations of deviant behavior (4). For example, the statistics from Gillette, Wyoming, deserve some attention. Kohrs (47) reported that such community's suicide-attempt rate rose to the point where there was one attempt for every 250 persons. Also, a government report showed that about 12 percent of the total county's population during the boom period developed a drinking problem (48).

## Environmental Impacts

Coal exploration and any succeeding mining and mine site processing affect the environment in many ways. Strip mining adversely affects the surface area at the digging site. Vegetation is removed; microflora and microorganisms are destroyed; soil, subsoil, and underlying strata are ruptured and displaced; wildlife must scatter or die; land uses shift dramatically; the surface is exposed to oxidation, and mineralogical alteration, weathering, and general topographic changes; and the air quality is temporarily degraded. However, this environmental devastation covers only a limited area and is generally temporary, because the land is systematically reclaimed (49, 50).

Certain environmental problems associated with coal mining are the results of earlier mining periods and present mining strategies. Those problems include: 1) the problem of the subsidence of the surface in many eastern coal fields, and the universality of such problems anywhere underground mining occurs without the adequate backfilling and stabilizing measures within the mine; and 2) the difficulty of long-term control of acidified mine water discharge, especially in the eastern part of the United States (51).

Obiechina and Badger (52) used an environmental impact matrix to analyze the environmental impacts of four alternative strip coal mining and reclamation strategies in four counties in eastern Oklahoma: 1) partial reclamation and active strip mining; 2) complete reclamation following strip mining; 3) complete reclamation concurrent with strip mining; and 4) no reclamation after strip mining. They found out that the net environmental impact was negative for the four strategies considered ranging from -5.53 for strategy 4 to -0.25 for strategies 2 and 3.

Coal development can adversely affect water quality. One of the most important factors influencing the quality of water near coal development sites is the quantity of effluents produced. At the mining site, sulfur compounds exposed by the process of mining may react with surface or groundwater to form acids, which later drain from the mine and pollute the streams below (29, 53). However, the "Surface Mining Control and Reclamation Act of 1977" requires that coal mining companies take adequate steps to prevent this type of pollution by requiring detention structures to prevent runoff from the mine site (54).

The other major factor affecting water quality is caused by disturbances to the land, such as: (1) surface disturbances, which can increase erosion, and the dissolved solids content and other pollutants in runoff; and (2) the disruptions of aquifers (49). Rowe and McWhorter (55) examined several surface coal mining sites in northwestern Colorado to quantify the salinity (dissolved solids content) caused by surface disturbance. They found out that annual salt loading from the disturbed land was between 2.13 and 2.37 tons per acre, which represents a 500 percent increase above the premining rate and suggests that groundwater seepage from the disturbed areas accounted for more than 99 percent of the salt load from such lands.

Hounslow, Fitzpatrick, Cerrillo, and Freeland (56) surveyed eight surface coal mines located in New Mexico, Colorado, Wyoming and Montana to examine aquifer disruptions due to strip mining. They determined that strip mining led to increased levels of carbonates, sulfates, clays, and sulfides. This phenomenon was caused by the augmented movement of water through the mine's disturbed overburden.

However, they pointed out that if the coal seams are located above the aquifer, the mining process usually does not alter the groundwater quality unless precipitation filters through the soil.

Cleaning, transporting, storing, burning, gasification, and liquefaction of coal may result in solid wastes, liquid wastes, and gaseous and particulate emissions. Large quantities of solid coal wastes have contributed to pollute both the air and water and threaten the health of wildlife and humans living near the sites where they are piled or stored. Liquid coal wastes cause little environmental damage since wastes are piped to on-site holding ponds where the suspended particles are allowed to settle and the water recycled for more cleaning operations. Gaseous and particulate emissions, as well as coal dust may cause the most serious environmental damages related with the use of coal (57).

Burning coal to generate heat or electricity, or use of coal to make coke for steel mills results in the emission of large amounts of sulfur oxides, nitrogen oxides, carbon dioxide, hydrocarbons and suspended particles. Sulfur oxide and nitrogen oxide gases are responsible for acid rain in New York, part of New England, and large portions of eastern Canada. Carbon dioxide emissions, hydrocarbon and nitrogen oxide emissions combined and particulate emissions have been associated with the "greenhouse effect", increased ozone production and reduction in the air quality, respectively (57). However, enforcement of regulations governing the emission of those gases and particles may minimize the environmental impacts caused by coal-fired power plants and steel mills (58).

## Effects of Reclamation on Surface-Mined Coal Lands

The Surface Mining Control and Reclamation Act of 1977 defined reclamation as the process of restoring the lands disturbed by energy development to their predevelopment uses (54). The prevailing practice is to conduct reclamation as an integral part of strip mining. Reclamation of strip-mined coal lands goes on concurrently with mining and generally includes backfilling, grading, replacing topsoil (which is usually separated and stockpiled in the course of mining), and establishing a vegetation cover (59). The time required to revert surface-mined coal lands to productive uses depends on such site-specific factors as soil characteristics and climate and on the management commitment made by the coal mine company and/or the landowners, counting control of grazing and other likely damaging activities (60).

Jacobs, Bradley, and Vanvig (26) conducted an experiment with 40 one-square-meter plots established on the native range and adjacent reclaimed land near Glenrock, Wyoming, to measure the effectiveness of reclamation of strip-mined coal lands based on forage production as a criterion. They found out that all of the reclaimed land's forage production was greater than the mean forage production on the native rangeland and that the grazing capacity of reclaimed areas was 1.56 acres per AUM, which represents an increase in production of over three times that on the native range.

Hoffman, Ries, and Lorenz (61) evaluated reclamation of strip-mined coal land using data on beef cattle performance from reclaimed sites and non-mined rangeland sites near Center, North Dakota. They found out that animal performance over a three-year period on reclaimed land was equal or superior to that on native range grazed early in the season. However, Sindelar (62) contends that reclaimed surface coal-mined lands are not comparable to native range in terms of species diversity, cover of perennial vegetation and seasonality of forage.

McCarthy (63) conducted a study to determine the success of the preplanned concurrent mining and reclamation project accomplished in Centralia, Washington. He concluded that the reclamation process resulted in improved water quality and volume, self-supporting vegetation, better topography and long range land use. Thus, the reclaimed land displayed betterment over its premining state.

LaFevers, Johnson, and Dvorak (64) analyzed some environmental and reclamation issues associated with coal mining in North Dakota. They argue that there are some environmental costs of reclamation which are difficult to treat. For example, regrading and soil compactation may cause higher erosion rates, causing increased stream sedimentation and decreased agricultural productivity; and extensive use of fertilizers may in the long run have an adverse cumulative effect on contiguous lands. However, these problems appear to be fundamentally short-term trade-offs inevitable if surface mined-coal lands are to be reverted to their predevelopment use.

# CHAPTER III

## ANALYTICAL TOOLS AND METHODOLOGY

A brief summary of the historical development, basic concepts, and assumptions of the input-output analysis and a description of the interregional input-output used in the study is presented in this chapter. A discussion also is presented of the sample surveys used to gather the primary data used in the study and the sources of secondary data.

### Historical Development of Input-Output Analysis

References to the economic interdependence problem started in the eighteenth century, when Francois Quesnay first discussed the topic in his "Tableaux Economique". Over a century later, Leon Walras developed the general equilibrium theory in his work named "Elements d'economic politique pure". His model integrated a set of equations, which represent the interdependence between the production sectors of an economy and the demand from each sector competing with it for the same production factors. Such a model also considered the costs of production, the supply and demand for the goods and production factors, and consumer income and expenditures allowing consumers to substitute the product of one sector for those of other sectors. Unfortunately, Walras' theory could not be verified empirically (65).

The input-output model being used now essentially is based on an empirical interindustry analysis conducted by Wassily Leontief in 1936. He developed the first input-output table for the U.S. economy using a general production theory centered upon the economic interdependence context (65). His model simplified the general equilibrium system of Walras. He deleted the effects of limited factor supplies and of input substitution from the model and used the assumption of "fixed production coefficients". These modifications allowed him to eliminate the effects of price changes on consumer demand, the purchase of intermediate goods, and the supply of labor and other production factors and validate the applicability of his model for economic studies (66).

Input-output analysis has received increasing attention because of its usefulness in explaining interrelationships among the respective industries of an economy and in projecting the likely impacts of exogenous shocks (autonomous changes) to an economic system in a more detailed manner than do export base models. Since Wasily Leontief developed such an analysis technique to describe the structure of the United States economy, it has been used to explain economic structure and to project economic impacts at the regional, state, and substate level.

## Theoretical Aspects of Input-Output Analysis

Input-output or interindustry economics is undoubtedly one of the most innovative developments in the evolution of economic analysis. It embodies three major economic features: 1) a simple form of linear programming, 2) a detailed description of aggregate flows, and 3) the simplest form of the Walrasian general equilibrium model.

The fundamental equation of the input-output model is:

$$X_i = \sum_{j=1}^{n} X_{ij} + Y_i \qquad (3.1)$$

Where: i and j = 1,2,....,n

$x_{ij}$ = the amount of input purchased by industry j from industry i

$Y_i$ = sales to final demand by industry i

$X_i$ = total output of industry i.

Equation 3.1 portrays a system of linear equations, one for each industry or producing sector of the economy. The output of each industry is divided between intermediate products or interindustry transactions described by $x_{ij}$ and sales to final demand. Sales to final demand are usually assumed to include sales for consumption, government, investment and exports.

Seven assumptions are made to facilitate empirical implementation of the model: (15, 66, 67)

a. There are no economies or diseconomies of scale.

b. No substitution among inputs occurs due to changes in relative prices or availability of new materials.

c. Each industry has a single production process.

d. Each industry produces a single, unique product.

e. Input supply functions are perfectly elastic.

f. Each industry is operating at full capacity.

g. Technology remains constant.

Assumptions a,b,c, and g indicate that a constant relationship exists between each industry's output and its input requirements. This relationship may be written as:

$$x_{ij} = a_{ij}X_j \qquad (3.2)$$

where: $a_{ij}$ = the production coefficient (direct coefficient) indicating the amount of output that industry j needs from industry i to produce one unit of output

$X_j$ = output level of industry j.

By substituting equation 3.2 into equation 3.1, we get:

$$X_i = \sum_{j=1}^{n} a_{ij}X_j + Y_i \qquad (3.3)$$

Equation 3.3 represents a system of n linear equations. These equations may be solved for $X_i$ if the values of $a_{ij}$ and $Y_i$ are known.

The latter equation may be written in matrix notation as:

$$X = AX + Y \qquad (3.4)$$

This equation can be solved for the vector X as follows:

$$X = (I-A)^{-1}Y \qquad (3.5)$$

where: X = vector of output for each industry, X

A = matrix of production coefficients (direct requirements coefficients or technical coefficients)

I = identity matrix

Y = vector of sales to final demand for each industry

$(I-A)^{-1}$ = matrix of interdependence coefficients which represent the direct and indirect requirements (and induced requirements when the model is closed with respect to households) to back one unit of sales to final demand.

Equation 3.5 is useful in short-run forecasting. Output projections can be calculated from such equation when final demand projections are available, i.e., $X_o = (I-A)^{-1}Y_o$ (3.6) where: $X_0$ and $Y_0$ = vectors including projected values of output and final demand, respectively.

Thus, a change in the final demand of industry j can produce changes in output of all industries as long as the entries in column j of matrix $(I-A)^{-1}$ are different from zero.

Criticisms of the input-output model from a theoretical point of view center mainly on its assumption of constant direct coefficients. This limitation restricts the use of such a model as a long-range forecasting technique. However, empirical studies show that under certain conditions, the fixed coefficients assumption seems to be realistic for the short run. One condition is that price relationships and the state of technology (which determine the coefficients) do not change during the projection period. Another condition is that the economic growth in the target area be due to the entry of new firms similar to those previously existing in the respective industries or sectors (rather than from increased output of existing firms) (15, 68).

## An Interregional Input-Output Model for Oklahoma and the Rest of the U.S.

The concept of multiregional or interregional economic models have long intrigued regional analysts. These models could explicitly quantify the linkages among the different regions of a nation. They circumvent one of the primary problems of single-region input-output models--that being the need for exogenous projections of exports. Thus, a multiregional or interregional input-output model may provide information of regional exports and imports of each industry, about the destinations and sources of shipments, and about the distribution and consumption of an industry's imports by other industries.

An interregional input-output model considers the combination of two sets of structural relationships: the interindustrial and interregional sets. Such a model relates industries by input-output activities and regions by trade and allows the researcher to analyze economic activities with respect to both input-output among industries and trade among regions.

The theoretical framework and the structure of the Oklahoma-Rest of U.S. interregional model used in the study will be discussed next. This model is closed with respect to the household industry. The data and data sources, as well as the procedures used to derive the technology matrix, trade matrix, and interregional interdependence coefficients matrix are given by Hirunruk (69).

The model considers two regions, Oklahoma and Rest of U.S. and 82 sectors. The regions are open to one another for trade. In this model, the Oklahoma coal mining sector is treated as an exogenous sector. A dummy sector, whose row and column entries are all zeroes, is used in the technology and trade (intraregional and interregional flows) matrices for Oklahoma to keep consistency with the number of sectors of those matrices for Rest of U.S., where the coal mining sector is treated as an endogenous sector. This approach was adopted because the data base available did not allow to develop technical and trade coefficients for the Oklahoma coal mining sector which would take into account the proposition that the increases in the Oklahoma coal production considered in the study would be consumed in the state. Such a data base only reflected the fact that most of the

Oklahoma coal was exported and that all of the coal consumed by the Oklahoma coal-fired electric power plants was imported from Wyoming.

Structure of the Model

The model considers two sets of equations. One set expresses certain balance relations, while the other expresses both balance and structural relations. The first set states that each industry's output in each region is equal to its sales to all industries and final demand sectors in the two regions. These equations may be written as:

$$X_i^m = \sum_{j=1}^{n} X_{ij}^{km} + Y_i^{km} \qquad (3.7)$$

where: m and k = 1,2 (regions, Oklahoma and Rest of U.S.),

i and j = 1,2,...., 82 (industries),

$X_i^m$ = total output of industry i in region m,

$x_{ij}^{km}$ = value of output of industry i from region k consumed by industry j in region m,

$Y_i^{km}$ = shipment of goods in final demand account from industry i in region k to region m. Here the term final demand refers to receipts and takes into account the fact that each region can also contribute to meet final demand at home and in the other region.

The latter set of structural relations consists of two subsets, which were introduced to allow a solution for the balance equations of the model. One subset defines the production structure in each region, while the other defines the trade structure between the two regions.

The regional production (direct or technical) coefficients are obtained from the interindustry transactions as in a single region input-output model. It is assumed that a constant relationship between each industry's output level and its input requirements exists. The production coefficients may be expressed as:

$$a_{ij} = \frac{x_{ij}^{m}}{X_j} \qquad (3.8)$$

where: $a_{ij}^{m}$ = amount of input purchased by industry j located in region m from industry i,

$X_j^{m}$ = output level of industry j in region m.

The technology matrix of the model is a block diagonal matrix displaying the regional production coefficient matrices. This matrix may be written as:

$$A = \left[\begin{array}{c|c} A^{OK} & 0 \\ \hline 0 & A^{RUS} \end{array}\right] \qquad (3.9)$$

where: A = technology matrix,

$A^{OK}$ = regional technical coefficient matrix for Oklahoma,

$A^{RUS}$ = regional technical coefficient matrix for Rest of U.S.

The trade structure expresses the per unit flow of commodities between and within the two regions. Again, fixed coefficients are assumed such that each region obtains its requirements of each commodity in accordance with a fixed regional supply. This structure is described by a set of trade coefficients for each commodity. The derivation of each trade coefficient is straightforward. Let r denote the value of a region's purchases of a commodity from itself and the other region. Then, $r_i^{km}$ is the value of the output purchased by region m from industry i in region k. The sum of purchases of commodities from industry i in region k by region m is denoted by $R_i^m$. Thus, the trade coefficient, $t_i^{km}$, is obtained by division:

$$t_i^{km} = \frac{r_i^{km}}{R_i^m} \qquad (3.10)$$

These coefficients may also be displayed as a block diagonal matrix. Each block refers to a commodity and describes the per unit trading patterns of the two regions in this commodity. Thus, the Oklahoma and Rest of U.S. interregional model's trade matrix, T, has four diagonal matrices, $T^{km}$. T may be written as:

$$T = \begin{array}{c} \\ \\ \end{array}\begin{array}{cc} \text{OK} & \text{RUS} \\ \left[\begin{array}{c:c} T^{11} & T^{12} \\ \hdashline T^{21} & T^{22} \end{array}\right] \end{array}\begin{array}{l} \\ \text{OK} \\ \text{RUS} \end{array} \qquad (3.11)$$

Each $T^{km}$ matrix is an 82 sector diagonal matrix. The matrices comprising the principal diagonal matrix represent intraregional shipments, so non-traded commodities are taken into account in such matrices. The off-diagonal matrices identify interregional shipments, so non-traded commodities received a zero value.

The two subsets of structural relations allow the computation of the interregional input-output coefficient matrix, B, which incorporates both production and trade coefficients. The interregional input-output coefficients, $b_{ij}^{km}$, designate the proportion of industry i's output purchased by region m from region k to produce a unit of output in industry j. Thus, $b_{ij}^{km}$ is computed as the product of $a_{ij} \cdot t_i^{km}$. It is assumed that commodities brought into a region are used in the same proportion by the industries of the other region as are inputs produced in such a region. In matrix notation, the interregional input-output coefficient matrix is computed as:

$$\left[\begin{array}{c|c} T^{11} & T^{12} \\ \hline T^{21} & T^{22} \end{array}\right] \cdot \left[\begin{array}{c|c} A^{OK} & 0 \\ \hline 0 & A^{RUS} \end{array}\right] = \left[\begin{array}{c|c} B^{11} & B^{12} \\ \hline B^{21} & B^{22} \end{array}\right] \quad (3.12)$$

or

$$T \cdot A = B$$

The technology matrix, A, and the trade matrix, T, are presented by Hirunruk (69).

Interregional interindustry flows can be calculated as the product of the interregional input-output coefficient matrix, B, and a diagonal matrix of regional output:

$$\left[\begin{array}{c|c} B^{11} & B^{12} \\ \hline B^{21} & B^{22} \end{array}\right] \cdot \left[\begin{array}{c|c} X^{OK} & 0 \\ \hline 0 & X^{RUS} \end{array}\right] = \left[\begin{array}{c|c} X^{11} & X^{12} \\ \hline X^{21} & X^{22} \end{array}\right] \quad (3.13)$$

The interregional input-output coefficient matrix, B, and the 1977 interregional interindustry flow matrix are not given in this study because of their size.

The complete Oklahoma-Rest of U.S. interregional input-output model can now be written as:

$$\begin{bmatrix} B^{11} & B^{12} \\ B^{21} & B^{22} \end{bmatrix} \cdot \begin{bmatrix} X^{OK} \\ X^{RUS} \end{bmatrix} + \begin{bmatrix} T^{11} & T^{12} \\ T^{21} & T^{22} \end{bmatrix} \cdot \begin{bmatrix} Y^{OK} \\ Y^{RUS} \end{bmatrix} = \begin{bmatrix} X^{OK} \\ X^{RUS} \end{bmatrix} \qquad (3.14)$$

or

$$B \cdot X + T \cdot Y = X$$

where: $X$ = regional output matrix,

$Y$ = regional final demand matrix.

The portions of final demand coming from each region are expressed as the product of the final demand matrix, Y, and the interregional trade coefficient matrix, T.

The previous equation can be solved for the vector X as follows:

$$X = (I-B)^{-1}\ TY \qquad (3.15)$$

where: $(I-B)^{-1}$ = the interregional interdependence coefficient matrix.

The direct, indirect, and induced requirements coefficients are shown by this matrix. The quantity of output of industry i in region k needed to satisfy one dollar's worth of region m final demand for goods or services of industry j are indicated by these coefficients. Consequently, a change in final demand for industry j's products in one of the two regions may cause a significant change in industry i's output of the other region. The 1977 interregional direct, indirect and induced input-output coefficient matrix, $(I-B)^{-1}$, which is not given in this study due to its size, is used to estimate the economic impacts of coal mining in Oklahoma.

## Application of Input-Output Analysis in the Study

Impact analysis involves estimating the effect on the regional economy of a specified change in the final demand for products of one or more economic sectors. Input-output analysis is a useful tool for estimating the effect of a new development project on output, income, and employment for an entire regional economy. It can also supply estimates of changes in output and employment for each economic sector.

Economic impacts emerging from changes in final demand are frequently estimated by means of multipliers obtained from input-output models. These multipliers express the relationships between expansion or contraction of a given sector and the total change in economic activity generated throughout the economy. The most common input-output multipliers are output, employment, and income multipliers.

The output multiplier for industry i measures the change in total output from all industries (or sectors) resulting from a one dollar change in final demand for the products of that industry. The employment multiplier expresses the total change in employment due to a one unit change in employment in a given sector. The income multiplier measures the total change in household income throughout the economy resulting from a one dollar change in income in a given industry. (For additional details of these multipliers and their computation, see Miernyk (65); and Doeksen and Schreiner (67)).

The multipliers by themselves are useful, but are not nearly as useful as the complete input-output model. Use of the complete model furnishes more information as to the distribution of the output, employment and income impacts than use of multipliers alone. In this study, we have access to such a model. Thus, it will be used for estimating those distributional impacts.

This study considers the estimation of output, employment and income impacts of coal development under three different scenarios: 1) "normal" (1980-82) level of demand for Oklahoma coal (e.g., 5 million tons per year), 2) increase of 25 percent in the "normal" level of demand for Oklahoma coal (e.g., 6.25 million tons per year), and 3) increase of 50 percent in the "normal" level of demand for Oklahoma coal (e.g., 7.5 million tons per year). The increase in the demand level considered under the second scenario is expected to be achieved if the Oklahoma coal-fired electric power plants use 10 percent of Oklahoma coal in their generation operations. The increase considered under the third scenario is expected to be achieved if the previous condition is satisfied and if new coal-fired electric power plants capable of burning a great percentage of Oklahoma coal are built in the state.

The first scenario is considered as a benchmark period. The final demand vector, $Y_0$, associated with coal mining for that period will be applied to the model to obtain the regional output, $X_0$, due to the first scenario's coal mining activity. In matrix notation, the equation used to compute $X_0$ may be written as:

$$X_o = (I-B)^{-1} TY_o \tag{3.16}$$

After computing $X_o$, regional employment and income for each sector (with the exception of the coal mining sector) can be estimated. Let G be a diagonal matrix (82 by 82), where element i in the principal diagonal is the employment-output ratio for industry j, which should be properly adjusted to take into consideration the change in labor productivity. By multiplying the matrix G by $X_o$, employment by sector can be computed. Accordingly,

$$L = \hat{G} \cdot X_o \tag{3.17}$$

where L = employment vector,

$\hat{G}$ = adjusted employment-output ratio diagonal matrix.

Likewise, income can be estimated as the product of the income-output ratio matrix by the $X_o$ vector. Hence, assuming constant income-output ratios,

$$M = H \cdot X \tag{3.18}$$

where M = income vector,

H = income-output ratio diagonal matrix.

The changes in regional output associated with the increases in coal mining considered in the second and third scenarios can be estimated as:

$$\Delta X = (I-B)^{-1} T\Delta Y \tag{3.19}$$

where $\Delta X$ = regional output change matrix,

$\Delta Y$ = final demand changes due to an increase in the coal mining activity.

After the changes in output associated with each coal mining development scenario have been computed, the impact on regional employment and income for each sector (with the exception of the coal mining sector) can be estimated. Procedures used to estimate these impacts are similar to those described to calculate employment and income under the first scenario. Let $\Delta L$ and $\Delta M$ denote the changes in employment and income. Hence,

$$\Delta L = \hat{G} \cdot \Delta X \tag{3.20}$$

and

$$\Delta M = H \cdot \Delta X \tag{3.21}$$

The income and employment generated by the coal mining activity under each development scenario were obtained from the coal mine operators' survey. The income corresponds to the wages and salaries paid to the coal mine workers by the coal mine companies.

## The Sample Surveys

The purpose of the three types of surveys was to obtain the data used to estimate the effects of coal mining and reclamation on the local economy and environment and to determine the factors that prevent Oklahoma's coal-fired electric power plants from using Oklahoma coal and the conditions that may induce them to use it. After consultations with county extension directors and specialists in the area from the University of Oklahoma Geological Survey, the Bureau of Land Management's Oklahoma Resource Area Office, the Office of Surface Mining, and the Oklahoma Department of Mines, survey forms were designed and pre-tested. Copies of the survey forms are in the Appendixes.

Three groups of people were questioned:

a. professionals, including county extension agents, soil conservationists, bankers, school superintendents, county commissioners, county treasurers, county assessors, Agricultural Stabilization and Conservation personnel and Oklahoma Employment Services personnel

b. superintendents of coal-fired electric power plants

c. coal company operators.

The survey forms were different for each group. The surveys were conducted between March and July of 1984.

The professionals selected to participate in the study were randomly chosen by the county extension directors in the study area. It was assumed that the sample of professionals was an unbiased sample and a cross-section of the population. Thus, the survey data for this group was expected to represent the general population. A total of 52 professionals participated in this survey in the 12 counties included in the study area (Table III).

Completed questionnaires were obtained from the superintendents of the five coal-fired electric power plants presently operating in Oklahoma (Western Farmers Electric Cooperative Hugo Plant, Oklahoma Gas and Electric Company Sooner Station, Public Service Company of Oklahoma Northeastern Station, Oklahoma Gas and Electric Company Muskogee Station, and the Grand River Dam Electric Generating Station). Some superintendents were reluctant to answer the questions regarding the f.o.b. price of coal and transportation cost paid per ton of Wyoming coal used in their generation operations because they considered such information as proprietary and confidential under the terms and provisions of their contracts, or because they were negotiating these costs and do not want to discuss them at that time.

TABLE III

INTENDED NUMBER OF PROFESSIONALS TO BE QUESTIONED AND ACTUAL NUMBER OF PROFESSIONALS QUESTIONED

| County | Number of Surveys Planned | Actual Number of Completed Surveys |
|---|---|---|
| Coal | 6 | 6 |
| Craig | 6 | 4 |
| Haskell | 11 | 8 |
| Latimer | 7 | 3 |
| LeFlore | 6 | 5 |
| McIntosh | 6 | 3 |
| Muskogee | 3 | 3 |
| Nowata | 6 | 3 |
| Okmulgee | 6 | 4 |
| Pittsburg | 10 | 7 |
| Rogers | 6 | 3 |
| Wagoner | 6 | 3 |
| TOTAL | 79 | 52 |

Seventeen of the twenty coal companies that were active during the surveying period were surveyed (Table IV). These companies accounted for 95.3 percent of the coal produced in Oklahoma in 1983. The three active coal companies not surveyed produced 2.6 percent, while the three that became inactive during 1983 produced 2.1 percent of the coal mined in the state in 1983.

The survey form for coal mine operators was designed having in mind that no firm accounts for expenditures on an SIC basis, the language ultimately employed in an interindustry model. Thus, an adequate translation from SIC codes into accounting language was implemented to design the question regarding the expenditures of the coal companies under the three production level scenarios considered in this study. Not all coal mine surveys were conducted as planned. It was found, for example, that some companies would have to refer for legal advice, while others did not want to reveal the information in the form desired. Two coal companies did not provide the information regarding their expenditures nor their possible employment figures under the three scenarios considered. Thus, their expenditures for each SIC sector and employment figures were estimated using some rough estimates of their total expenditures, which were allocated to each SIC sector based on the information provided by companies of similar size surveyed.

## Secondary Data

Secondary (published) data were used in this study to supplement the data gathered through the survey process and to reinforce the discussion of some topics where primary data were unavailable. These

TABLE IV

NUMBER OF ACTIVE COAL MINE COMPANIES AND NUMBER OF SUCH COMPANIES SURVEYED

| County | Active | Surveyed |
|---|---|---|
| Coal | 1 | 0 |
| Craig | 6 | 5 |
| Haskell | 4 | 4 |
| Latimer | 2 | 2 |
| LeFlore | 2 | 2 |
| McIntosh | 3 | 1 |
| Muskogee | 1 | 1 |
| Nowata | 2 | 2 |
| Okmulgee | 1 | 1 |
| Pittsburg | 1 | 1 |
| Rogers | 5 | 5 |
| Wagoner | 4 | 4 |
| TOTAL | 20[a] | 17[b] |

[a,b]Total numbers of active and surveyed coal companies are not the sum of their respective columns because some companies operate in more than one county.

data were obtained from a wide variety of sources, especially government (federal and state) sources. Data on coal production, number of active coal companies, and coal mine workers by counties were obtained from the Oklahoma Department of Mines. Data concerning f.o.b. price of Oklahoma coal, amount of coal consumed by the Oklahoma coal-fired electric power plants and average delivered price of coal consumed by such plants were gathered from several U.S. Department of Energy publications. Data used to discuss the socioeconomic conditions of the study area were obtained from the U.S. Bureau of Economic Analysis, the U.S. Bureau of the Census, and the Oklahoma Employment Security Commission. Data regarding coal shipments by barge on the Oklahoma portion of the McClellan-Kerr River Navigation System were collected from the Tulsa District of the U.S. Army Corps of Engineers.

# CHAPTER IV

## FLUCTUATING CONDITIONS AND PROBLEMS OF THE COAL REGION ECONOMY

Oklahoma's Coal Region has long been plagued by a multitude of problems - poverty, unemployment, the outmigration of much of its talented young people and dependence on welfare funds. During the early 1980's the socioeconomic plight of this region worsened due to the economic recession which began in 1981.

### Poverty and Income Sources

Poverty among the Coal Region's 1980 population of 330,034 is of first importance. Of the 95,826 families in the region in 1979, 12,779 families (13.3 percent) had incomes below $7,412, the average poverty threshold for a family of four persons (70). Of these families, 3,962 relied on social security payments as their source of income, and 3,700 relied on public assistance. These figures represented 31 and 29 percent of the total number of families in the category.

The poverty rates of the Coal Region, Oklahoma and the Nation as a whole are compared in Table V. The poverty rate in the Coal Region exceeded both that of the Nation and of Oklahoma.

TABLE V

TOTAL NUMBER OF FAMILIES, POVERTY FAMILIES, AND SOURCE OF INCOME OF POVERTY FAMILIES IN THE U.S., OKLAHOMA AND THE COAL REGION IN 1979

| Area | Total Number of Families | Families Under Poverty Threshold | | Source of Income of Poverty Families | | | |
|---|---|---|---|---|---|---|---|
| | | | | Social Security | | Public Assistance | |
| | | No. | % | No. | % | No. | % |
| United States | 59,190,133 | 5,670,214 | 9.6 | 1,178,847 | 20.8 | 1,840,830 | 32.5 |
| Oklahoma | 830,508 | 85,824 | 10.3 | 21,808 | 25.4 | 21,740 | 25.3 |
| Coal Region | 95,826 | 12,779 | 13.3 | 3,962 | 31.0 | 3,700 | 29.0 |

Source: (70, 71)

## Unemployment Situation

Unemployment is a primary contributor to the poverty conditions. In 1976, the unemployment rate in weighted average terms was 12.1 percent. Data on unemployment and employment in Oklahoma and the Coal Region, as well as the rates of unemployment for the period 1976-83 are presented in Table VI.

The unemployment situation in the Coal Region was far worse than that in Oklahoma as a whole. Between 1976 and 1979, the rate of unemployment in the Coal Region declined somewhat. After 1979, it increased, except in 1981, and reached 12.4 percent in 1983, compared to 8.2 percent for the state. The increase in the period 1982-83 was associated with the economic recession that began in 1981.

## Per Capita Personal Income

Another indicator of the deep-seated poverty of the Coal Region is its low per capita personal income. In 1976, the per capita personal income in the Coal Region was $4,360 while that in Oklahoma and that in the United States were $5,694 and $6,367, respectively. The per capita personal income data for the United States, Oklahoma and the Coal Region for the period 1976-1981 are presented in Table VII. Also, the Coal Region's per capita personal income level is compared as a percentage of that of the United States and Oklahoma, as well as Oklahoma's to the United States.

From 1976 to 1981, the per capita personal income of Oklahoma and the Coal Region increased relative to that of the United States. However, in 1978 and 1980 the per capita personal income in the Coal

TABLE VI

EMPLOYMENT, UNEMPLOYMENT, AND RATE OF UNEMPLOYMENT FOR OKLAHOMA AND THE COAL REGION, 1976-1983

| Year | Oklahoma | | | Coal Region | | |
|---|---|---|---|---|---|---|
| | Total Employment | Total Unemployment | Rate of Unemployment (%) | Total Employment | Total Unemployment | Rate of Unemployment (%) |
| 1976 | 1,095,625 | 86,092 | 7.3 | 102,988 | 12,458 | 12.1 |
| 1977 | 1,145,858 | 50,983 | 4.3 | 110,025 | 8,135 | 7.4 |
| 1978 | 1,205,558 | 45,658 | 3.6 | 113,142 | 6,940 | 7.0 |
| 1979 | 1,245,917 | 45,017 | 3.5 | 121,117 | 6,690 | 5.5 |
| 1980 | 1,261,000 | 64,000 | 4.8 | 121,770 | 9,575 | 7.9 |
| 1981 | 1,338,742 | 51,325 | 3.7 | 125,824 | 7,442 | 5.9 |
| 1982 | 1,387,925 | 82,375 | 5.6 | 133,178 | 11,428 | 8.6 |
| 1983 | 1,370,650 | 123,192 | 8.2 | 130,287 | 16,190 | 12.4 |

Source: (72)

TABLE VII

PER CAPITA PERSONAL INCOME FOR THE U.S., OKLAHOMA, AND THE COAL REGION, 1976-1981

| Year | U.S. (dollars) | Oklahoma (dollars) | Oklahoma as % of U.S. | Coal Region (dollars) | Coal Region as % of U.S. | Coal Region as % of Oklahoma |
|---|---|---|---|---|---|---|
| 1976 | 6,367 | 5,694 | 89.4 | 4,360 | 68.5 | 76.6 |
| 1977 | 6,894 | 6,306 | 91.5 | 4,831 | 70.1 | 76.6 |
| 1978 | 7,776 | 7,154 | 92.0 | 5,399 | 69.4 | 75.5 |
| 1979 | 8,657 | 8,141 | 94.0 | 6,200 | 71.6 | 76.2 |
| 1980 | 9,503 | 9,097 | 95.7 | 6,797 | 71.5 | 74.7 |
| 1981 | 10,582 | 10,241 | 96.8 | 7,652 | 72.3 | 74.7 |

Source: (73)

Region decreased relative to that of the United States and Oklahoma. Even though the per capita personal income for such region increased during the period 1976-81, it was only 74.7 percent of the state's per capita personal income, and 72.3 percent of the United States' in 1981.

## Outmigration of Workforce

The Coal Region has suffered from the outmigration of much of its workforce. With fewer jobs available, much of the labor force has moved from the Coal Region to areas where employment opportunities have been more abundant, e.g., to Tulsa and Oklahoma City.

As a result of net outmigration, population in the Coal Region decreased between 1950 and 1960. However, from 1960 to 1980 this pattern was reversed. Population figures and percent changes for the period 1950-1980 are presented in Table VIII.

## Quality of Health Services

One factor which also contributes to the poverty cycle in the Coal Region is low quality of health services. In 1981, the total number of physicians in the region was 303. Given a population of 275,817, the ratio of physicians to the population was extremely low, with 1 physician for every 1,137 persons (74).

## Educational Attainment

Academic and vocational training in the Coal Region is limited. According to 1980 Census of Population data, the region's population

TABLE VIII

POPULATION AND PERCENT CHANGE FOR OKLAHOMA AND THE COAL REGION: 1950, 1960, 1970, AND 1980

| | Population | | | | Percent Change | | |
|---|---|---|---|---|---|---|---|
| Area | 1950 | 1960 | 1970 | 1980 | 1950-60 | 1960-70 | 1970-80 |
| Oklahoma | 2,233,351 | 2,328,284 | 2,559,463 | 3,025,290 | 4.3 | 9.9 | 18.2 |
| Coal Region | 302,599 | 260,491 | 275,817 | 333,034 | -13.9 | 5.9 | 20.8 |

Source: (75)

exhibits low educational levels - as measured by educational attainment of the population 25 years of age and over (70).

The 1980 median level of education for this population group ranged from a low of 10.7 years of school completed in Coal County to a high of 12.4 in Rogers and Wagoner Counties. The median level of education for all Oklahoma residents was 12.5 years. Also, 44 percent of the people 25 years and over in the Coal Region had not graduated from high school, while for the state as a whole, only one-third of such a population group did not earn a high school diploma. Moreover, the region has a substantial legacy of low educational attainment, although the situation has improved dramatically over the past two decades.

## Coal Industry Trends

The alternating boom and bust periods in which coal production and coal prices rise and fall as supply and demand dictate might further complicate matters causing some hardships in the Coal Region's Counties. In 1947, coal production in the United States reached almost 631 million tons, its highest level up to that time. However, from 1948 to 1961 production fell 36 percent. Nationwide, employment in the coal industry declined even more quickly than production itself with a 15 year decrease of 63 percent. Between 1962 and 1983, coal production increased from 439 million tons to 780 million tons, reaching a record high 838 million tons in 1982.

Oklahoma's trend in coal production has followed that of the United States as a whole, although perhaps lagged a few years.

Production declined to 825,255 tons in 1967. As a result of this decline in production, coal employment in the Coal Region dropped from 2,300 in 1947 to 211 in 1967, a decrease of 91 percent (12). Consumer prices rose 32 percent in those years, but the price of coal fell from $4.99 per ton in 1948 to $4.48 per ton in 1967, a decrease of 10 percent (76).

Since the early 1970's the demand for coal has greatly increased. Due to the energy crisis and the enactment of government policies to conserve energy and reduce the dependence on foreign oil, there has been a renewed interest in the use of coal as a fuel source. As the demand for coal increased, so also did the price of coal and the amount produced. As a result of this increase in demand, coal employment in the study region rose from 552 in 1970 to 1,804 in 1981. However, the decrease in the demand for Oklahoma coal that began in 1982 has caused coal mining employment in the Coal Region to decline to 1,024 in 1983, its lowest level since 1975 (12). Employment in coal mining is important for this region where unemployment and underemployment are relatively high.

The number of coal companies operating in the Coal Region during the period 1976-1983 is presented in Table IX. Between 1976 and 1979 the number of coal companies increased from 32 to 45. This represents an increase of 41 percent. This increase was due to the expansion in the coal demand that took place during that period. However, from 1980 to 1983 the number of coal companies decreased from 39 to 20. This decline has been partly caused by the financial burden of the more strict strip mining and reclamation regulations of PL 95-87.

TABLE IX

NUMBER OF ACTIVE COAL MINE COMPANIES
IN THE COAL REGION, 1976-1983

| Year | Number |
|---|---|
| 1976 | 32 |
| 1977 | 39 |
| 1978 | 43 |
| 1979 | 45 |
| 1980 | 39 |
| 1981 | 35 |
| 1982 | 31 |
| 1983 | 20 |

Source: (12)

The decrease in the demand for coal caused by the economic recession that began in 1981 is also responsible for some of the decline in the number of coal companies operating in the Coal Region.

The conflicts between the Office of Surface Mining (OSM) and the Oklahoma Department of Mines, which have accentuated during 1983 and 1984, may affect the number of coal company operators that will remain in business. OSM has contended that ODOM is not implementing, administering, maintaining and enforcing its approved program to regulate surface coal mining and reclamation operations in the state of Oklahoma. As a result of this contention, OSM has taken control of the implementation, administration and enforcement of such program, with the exception of enforcement actions initiated by ODOM prior to April 12, 1984.

# CHAPTER V

# ECONOMIC IMPACTS OF COAL MINING

The economic impacts of coal mining in Eastern Oklahoma are presented in this chapter. First, the final demand vectors associated with each of the three scenarios considered in the study are analyzed. Second, the output, income, and employment impacts of coal mining in Oklahoma are discussed. Finally, the distributional shipments of coal by transportation modes and the commuting patterns of coal mine workers are presented and analyzed.

## Final Demand Vectors

Final demand for Oklahoma output from the coal mining sector for each of the three scenarios considered in the study were assembled from data on expenditures per year in the state of Oklahoma under each of those scenarios. This information was obtained from the coal mine operators survey. Those data were classified according to the 1977 input-output model of 82 sectors for Oklahoma to yield the final demand vectors. These vectors, as well as the changes in final demand for the second and third scenarios are presented in Table X.

The Oklahoma coal mining industry requires output from 21 input-output sectors of the economy. It uses land from the livestock and livestock products sector and from the federal government

## TABLE X

## OKLAHOMA FINAL DEMAND INDUCED BY THREE COAL DEVELOPMENT SCENARIOS INPUT-OUTPUT SECTOR ($1,000 IN 1984 PRICE LEVELS)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 1. Livestock and livestock products | 2,396.0 | 3,165.1 | 769.1 | 4,272.8 | 1,876.8 |
| 2. Crops and other agricultural products | 548.2 | 703.2 | 155.0 | 845.9 | 297.7 |
| 9. New Construction | 650.2 | 775.8 | 125.6 | 843.5 | 193.3 |
| 10. Maintenance and repair construction | 9,624.4 | 12,249.2 | 2,624.8 | 15,225.5 | 5,601.1 |
| 25. Chemicals and selected chemical products | 10,393.6 | 13,817.0 | 3,423.4 | 16,701.3 | 6,307.7 |
| 43. Construction and mining machinery | 27,178.0 | 36,826.0 | 9,648.0 | 45,322.0 | 18,144.0 |
| 44. Materials handling machinery and equipment | 3,187.6 | 4.229.6 | 1,042.0 | 5,286.5 | 2,098.9 |
| 49. Office, computing and accounting machines | 199.0 | 275.0 | 76.0 | 327.5 | 128.5 |
| 57. Motor vehicles and equipment | 658.0 | 807.2 | 149.2 | 932.4 | 274.4 |
| 59. Other transportation equipment | 209.8 | 218.6 | 8.8 | 230.4 | 20.6 |

TABLE X (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 63. Transportation and warehousing | 5,673.9 | 7,025.2 | 1,351.3 | 9,282.0 | 3,608.1 |
| 66. Water supply and sanitary services | 213.0 | 251.0 | 38.0 | 326.6 | 113.6 |
| 68. Finance and insurance | 3,220.6 | 3,953.2 | 732.6 | 4,573.2 | 1,352.6 |
| 69. Real estate and rental | 3,729.0 | 4,661.3 | 932.3 | 5,593.5 | 1,864.5 |
| 71. Business services | 1,316.7 | 1,700.9 | 384.2 | 2,045.4 | 728.7 |
| 73. Automobile repair and services | 8,992.0 | 10,417.8 | 1,425.8 | 13,461.5 | 4,469.5 |
| 76. Federal government enterprises | 534.0 | 591.8 | 57.8 | 624.5 | 90.5 |
| 77. State and local government enterprises | 327.0 | 389.8 | 62.8 | 437.0 | 110.0 |
| 78. Petroleum products production | 18,346.7 | 24,743.2 | 6,396.5 | 30,768.5 | 12,421.8 |
| 81. Electricity and hydropower | 1,510.2 | 1,816.2 | 306.0 | 2,184.7 | 674.5 |
| 82. Household | 32,277.3 | 38,444.4 | 6,167.1 | 45,980.9 | 13,703.6 |
| TOTAL | 131,185.2 | 167,061.5 | 35,876.3 | 205,265.6 | 74,080.4 |

enterprises sector. Coal mine operators survey data indicated that 74.6 and 4.7 percent of the coal currently being mined is on land leased from cattle ranchers and on federal land leased through the Bureau of Land Management, respectively; while the rest of the coal is being mined on land owned by the coal companies.

Also, the coal mining industry uses output from the following sectors: crops and agricultural products (seeds for revegetation), new construction (office buildings, warehouses, conservation and development facilities and access structures), maintenance and repair construction, chemicals and selected chemical products (explosives and fertilizers), construction and mining machinery (including parts), materials handling and equipment (trucks, tractors, conveyors, monorail systems parts and accessories), office, computing and accounting machines, motor vehicles and equipment (including parts and accessories), other transportation equipment (mobile homes, trailers, and campers), transportation and warehousing, water supply and sanitary services, finance and insurance, real estate and rental (including royalties paid by coal mine operators to land owners), business services (professional services, including notary public, legal fees and accounting services), automobile repair and services, federal government enterprises (includes fines for violations), state and local government enterprises (includes fines for violations), petroleum products production (gasoline, diesel fuel and related products), electricity and hydropower, and household (wages and salaries paid to coal mine workers).

The value of the final demand for Oklahoma goods and services required by the coal mining activity under a normal demand level

(Scenario I) for Oklahoma coal would total $131,185,200 (in 1984 dollars). Of that amount 24.6 percent ($32,277,300) corresponds to wages and salaries paid by the coal companies to the household sector, 20.7 percent ($27,178,000) was paid to the construction and mining machinery sector, 14.0 percent ($18,346,700) to the petroleum products production sector, 7.9 percent ($10,393,600) to the chemicals and selected chemical products sector, 7.3 percent ($9,624,400) to the maintenance and repair construction sector, 6.9 percent ($8,992,000) to the automobile repair and services sector, 4.3 percent ($5,673,900) to the transportation and warehousing sector, 2.9 percent ($3,729,000) to the real estate and rental sector, 2.5 percent ($3,220,600) to the finance and insurance sector, and 2.4 percent ($3,187,600) to the materials handling machinery and equipment sector.

An increase of 25 percent in the normal level of demand for Oklahoma coal (Scenario II) will cause the final demand for Oklahoma output to increase by 27.3 percent ($35,876,300). Under this scenario, the ranking of the expenditures for those sectors with a share of 2 percent or greater is the same as that of Scenario I.

The greatest increase in final demand would be experienced by the construction and mining machinery sector. The final demand for this sector's output would increase by $9,648,000 (35.5 percent). Final demand for output from the petroleum products production sector would expand by $6,396,500 (34.9 percent). The expenditures on wages and salaries would increase by 19.1 percent ($6,167,100) totalling $38,444,400. The changes in final demand experienced by the chemicals and selected chemical products sector and by the maintenance and repair construction sector would be $3,423,400 (32.9 percent) and

$2,624,800 (27.3 percent), respectively. Finally, it is worthwhile to indicate that the final demand of the rest of the sectors providing goods and services to the coal mining industry would also increase.

The final demand associated with an increase of 50 percent in the normal level of demand for Oklahoma coal (Scenario III) would reach $205,256,600 (in 1984 dollars). The increase in final demand associated with this scenario would amount to $74,080,400 (56.5 percent). Sectors having the greatest final demand shares would be the household sector (22.4 percent), construction and mining machinery sector (22.1 percent), petroleum products production sector (15.0 percent), chemicals and selected chemical products sector (8.1 percent), maintenance and repair construction sector (7.4 percent), automobile repair and services sector (6.6 percent), and transportation and warehousing sector (4.5 percent). Of these shares, those for the household and automobile repair and services sectors would be somewhat lower as compared with those of Scenario I, while the remaining shares would be higher.

The sectors experiencing the greatest increase in final demand as a result of a 50 percent increase in the level of demand for Oklahoma coal would be: construction and mining machinery, household, petroleum products production, chemicals and selected chemical products, maintenance and repair construction, automobile repair and services, transportation and warehousing, and materials handling machinery and equipment. The final demand of these sectors would increase by 66.8 percent ($18,144,000), 42.5 percent ($13,703,600), 67.7 percent ($12,421,800), 60.7 percent ($6,307,700), 58.2 percent ($5,601,100), 49.7 percent ($4,469,500), 63.6 percent ($3,608,100), and 65.9 percent ($2,098,900), respectively.

Expenditures data for goods and services purchased from the Rest of U.S. were not collected. However, the impacts of the final demand for those goods and services would be felt predominately in sectors outside Oklahoma. Thus, the final demand (and the changes in final demand) for goods and services purchased by the Oklahoma coal mining industry from the Rest of U.S. was assumed to be equal to zero.

## Estimating Economic Impacts of Coal Mining

The output, income, and employment impacts of coal mining in Oklahoma are projected under the assumptions of three separate scenarios. Scenario I assumes that a normal demand level of 5 million tons per year is going to be reached in 1985. This level of demand for Oklahoma coal is consistent with the average coal production for the period 1980-1982. Scenario II and Scenario III assume that the demand level for Oklahoma coal is going to increase to 6.25 million tons in 1989 or to 7.5 million tons in the same year. Results of the coal mine operators survey indicated that those operators could meet those levels of demand.

The final demand vectors shown on Table X are expressed in 1984 dollars. Since the input-output model used in the study is based on 1977 prices, those vectors were converted to 1977 dollars before applying the model. Different price indexes were used to deflate those vectors. Final demands for goods and services from the livestock and livestock products sector were deflated using the index of prices received by livestock farmers (148.65). Those final demands for crops and other agricultural products were deflated using the index of price received by crop farmers (137.88). The final demands for the chemicals and selected chemical products, construction and mining machinery, materials handling machinery and equipment, office, computing and accounting machines, motor vehicles and equipment, other transportation equipment, water supply and sanitary services, automobile repair and services, petroleum products production, and electricity and hydropower sectors were converted to 1977 dollars using the producer price index (159.85). Wages and salaries were transformed using the hourly earnings index for nonagricultural workers (78.76). Those final demands for federal government enterprises and state and local government enterprises sectors were not deflated. The final demands for the rest of the sectors listed on Table X were deflated using the consumer price index (169.40).

## Output Impacts

The final demand vector for Scenario I and the final demand changes encompassed by Scenario II and III were applied to the interdependence coefficient matrix of the input-output model to obtain output projections associated with each of those scenarios, as described in Chapter III. The output projections for each of those scenarios, as well as the output changes caused by increasing the normal level of demand for Oklahoma coal by 25 and 50 percent are presented in Table XI. The total output associated with each scenario is given in 1977 and in 1984 dollars. The 1984 output value was obtained by inflating the former value with the 1984 consumer price index (169.4), which could be useful for local planners and decision makers.

## TABLE XI

## OKLAHOMA OUTPUT INDUCED BY THREE COAL DEVELOPMENT SCENARIOS BY INPUT-OUTPUT SECTOR ($1,000 IN 1977 PRICES)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 1. Livestock and livestock products | 2,035.3 | 2,660.4 | 625.1 | 3,538.4 | 1,503.1 |
| 2. Crops and other agricultural products | 1,346.9 | 1,707.1 | 360.2 | 2,123.4 | 776.5 |
| 3. Forestry and fishery products | 120.9 | 148.5 | 27.6 | 179.9 | 59.0 |
| 4. Agricultural, forestry and fishery services | 259.5 | 325.9 | 66.4 | 405.9 | 146.4 |
| 5. Iron and ferroalloy ores mining | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6. Nonferrous metal ores mining | 3.2 | 4.2 | 1.0 | 5.1 | 1.9 |
| 7. Stone and clay mining and quarrying | 226.9 | 288.9 | 62.0 | 354.9 | 128.0 |
| 8. Chemical and fertilizer mineral mining | 0.7 | 0.9 | 0.2 | 1.1 | 0.4 |
| 9. New construction | 406.8 | 485.3 | 78.5 | 527.7 | 120.9 |
| 10. Maintenance and repair construction | 8,908.3 | 11,252.4 | 2,344.1 | 13,900.4 | 4,992.1 |
| 11. Ordnance accessories | 23.1 | 28.4 | 5.3 | 34.3 | 11.2 |
| 12. Food and kindred products | 3,407.5 | 4,189.9 | 782.4 | 5,088.8 | 1,681.3 |
| 13. Tobacco manufacturers | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14. Broad and narrow fabrics, yarn and thread mills | 2.4 | 2.9 | 0.5 | 3.5 | 1.1 |
| 15. Miscellaneous textile goods and floor coverings | 0.8 | 1.0 | 0.2 | 1.3 | 0.5 |
| 16. Apparel | 60.8 | 74.6 | 13.8 | 90.3 | 29.5 |

TABLE XI (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 17. Miscellaneous fabricated textile products | 2.7 | 3.3 | 0.6 | 4.0 | 1.3 |
| 18. Lumber and wood products, except containers | 22.5 | 28.4 | 5.9 | 34.6 | 12.1 |
| 19. Wood containers | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20. Household furnitures | 8.8 | 10.8 | 2.0 | 13.1 | 4.3 |
| 21. Other furniture and fixtures | 1.1 | 1.4 | 0.3 | 1.7 | 0.6 |
| 22. Paper and allied products, except containers | 8.7 | 10.8 | 2.1 | 13.2 | 4.5 |
| 23. Paper board containers and boxes | 7.1 | 8.9 | 1.8 | 10.9 | 3.8 |
| 24. Printing and publishing | 360.3 | 443.5 | 83.2 | 536.5 | 176.2 |
| 25. Chemicals and selected chemical products | 6,774.8 | 8,999.7 | 2,224.9 | 10,881.4 | 4,106.6 |
| 26. Plastics and synthetic materials | 1.2 | 1.5 | 0.3 | 1.8 | 0.6 |
| 27. Drugs, cleaning and toilet preparations | 9.9 | 12.1 | 2.2 | 14.7 | 4.8 |
| 28. Paints and allied products | 1.5 | 1.9 | 0.4 | 2.3 | 0.8 |
| 29. Paving and roofing material | 1,248.9 | 1,534.6 | 285.7 | 1,860.2 | 611.3 |
| 30. Rubber and miscellaneous plastic products | 188.6 | 236.9 | 48.3 | 290.4 | 101.8 |
| 31. Leather tanning and finishing | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 |

TABLE XI (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 32. Footwear and other leather products | 3.6 | 4.5 | 0.9 | 5.4 | 1.8 |
| 33. Glass and glass products | 83.0 | 101.5 | 18.5 | 124.2 | 41.2 |
| 34. Stone and clay products | 459.3 | 581.0 | 121.7 | 714.5 | 255.2 |
| 35. Primary iron and steel manufacturing | 228.0 | 305.5 | 77.5 | 376.0 | 148.0 |
| 36. Primary nonferrous metal manufacturing | 56.8 | 74.0 | 17.2 | 90.5 | 33.7 |
| 37. Metal containers | 3.6 | 4.6 | 1.0 | 5.6 | 2.0 |
| 38. Heating, plumbing and structural metal products | 276.9 | 352.2 | 75.3 | 430.1 | 153.2 |
| 39. Screw machine products and stamping | 8.5 | 10.7 | 2.2 | 13.2 | 4.7 |
| 40. Other fabricated metal products | 259.3 | 329.4 | 70.1 | 404.8 | 145.5 |
| 41. Engines and turbines | 27.8 | 37.0 | 9.2 | 45.6 | 17.8 |
| 42. Farm and garden machinery | 1.5 | 1.9 | 0.4 | 2.3 | 0.8 |
| 43. Construction and mining machinery | 17,174.9 | 23,270.9 | 6,096.0 | 28,639.6 | 11,464.7 |
| 44. Materials handling machinery and equipment | 1,997.8 | 2,650.7 | 652.9 | 3,313.0 | 1,315.2 |
| 45. Metal working machinery and equipment | 0.9 | 1.2 | 0.3 | 1.4 | 0.5 |
| 46. Special industry machinery and equipment | 0.8 | 1.0 | 0.2 | 1.3 | 0.5 |

TABLE XI (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 47. General industrial machinery and equipment | 35.6 | 47.6 | 12.0 | 58.6 | 23.0 |
| 48. Miscellaneous machinery, except electrical | 14.8 | 19.3 | 4.5 | 23.9 | 9.1 |
| 49. Office, computing and accounting machines | 129.1 | 178.0 | 48.9 | 212.0 | 82.9 |
| 50. Service industry machines | 32.4 | 39.3 | 6.9 | 49.1 | 16.7 |
| 51. Electric industrial equipment and apparatus | 10.3 | 13.5 | 3.2 | 16.6 | 6.3 |
| 52. Household appliances | 1.5 | 1.8 | 0.3 | 2.2 | 0.7 |
| 53. Electric lighting and wiring equipment | 3.6 | 4.5 | 0.9 | 5.5 | 1.9 |
| 54. Radio, TV and communication equipment | 49.2 | 60.3 | 11.1 | 73.4 | 24.2 |
| 55. Electronic components and accessories | 1.1 | 1.3 | 0.2 | 1.6 | 0.5 |
| 56. Miscellaneous electrical machinery and supplies | 3.3 | 4.1 | 0.8 | 5.0 | 1.7 |
| 57. Motor vehicles and equipment | 506.2 | 619.4 | 113.2 | 724.8 | 218.6 |
| 58. Aircrafts and parts | 43.9 | 54.5 | 10.6 | 67.8 | 23.9 |
| 59. Other transportation equipment | 146.6 | 155.5 | 8.9 | 167.0 | 20.4 |
| 60. Scientific and controlling instruments | 31.1 | 38.5 | 7.4 | 46.8 | 15.7 |

TABLE XI (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 61. Optical, ophthalmic, and photo equipment | 0.3 | 0.3 | 0.0 | 0.4 | 0.1 |
| 62. Miscellaneous manufacturing | 92.4 | 113.5 | 21.1 | 137.5 | 45.1 |
| 63. Transportation and warehousing | 8,432.2 | 10,484.4 | 2,052.2 | 13,251.8 | 4,819.6 |
| 64. Communication, except radio and TV | 2,553.8 | 3,153.0 | 599.2 | 3,830.9 | 1,277.1 |
| 65. Radio and TV broadcasting | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 66. Water supply and sanitary services | 1,356.0 | 1,663.9 | 307.9 | 2,030.8 | 674.8 |
| 67. Wholesale and retail trade | 15,585.6 | 19,181.3 | 3,595.7 | 23,287.7 | 7,702.1 |
| 68. Finance and insurance | 8,501.1 | 10,459.2 | 1,958.1 | 12,540.0 | 4,038.9 |
| 69. Real estate and rental | 17,748.0 | 21,891.9 | 4,143.9 | 26,534.7 | 8,786.7 |
| 70. Hotels and personal and repair services except auto | 2,357.8 | 2,897.9 | 540.1 | 3,509.6 | 1,151.8 |
| 71. Business services | 7,058.8 | 8,820.1 | 1,761.3 | 10,723.9 | 3,665.1 |
| 72. Eating and drinking places | 4,667.2 | 5,740.1 | 1,072.9 | 6,954.4 | 2,287.2 |
| 73. Automobile repair and services | 7,485.7 | 8,813.4 | 1,327.7 | 11,219.4 | 3,733.7 |
| 74. Amusements | 1,124.8 | 1,380.4 | 255.6 | 1,670.8 | 546.0 |
| 75. Health, educational and social services and non-profit organizations | 7,252.1 | 8,888.9 | 1,636.8 | 10,755.7 | 3,503.6 |
| 76. Federal government enterprises | 1,242.3 | 1,466.6 | 224.3 | 1,683.6 | 441.3 |
| 77. State and local government enterprises | 605.3 | 732.1 | 126.8 | 853.0 | 247.7 |

TABLE XI (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 78. Petroleum products production | 14,945.3 | 19,864.9 | 4,919.6 | 24,719.4 | 9,774.1 |
| 79. Natural gas production | 2,701.7 | 3,395.4 | 693.7 | 4,156.0 | 1,454.3 |
| 80. Coal mining | -- | -- | -- | -- | -- |
| 81. Electricity and hydropower | 4,689.1 | 5,817.1 | 1,128.0 | 7,061.5 | 2,372.4 |
| 82. Household | 85,832.3 | 105,133.6 | 19,301.3 | 127,170.4 | 41,338.1 |
| TOTAL | 241,262.5 (408,698.7)[a] | 301,326.0 (510,446.2)[a] | 60,063.5 (101,747.6)[a] | 367,633.2 (622,770.6)[a] | 126,370.7 (214,072.0)[a] |

[a] Totals expressed in 1984 price levels

Under Scenario I the estimated total output generated directly, indirectly and induced by the coal mining activity would amount to $241,262,500 (in 1977 dollars). This output would come primarily from the household ($85,832,300 or 35.6 percent), rental and real estate ($17,748,000 or 7.4 percent), construction and mining machinery ($17,174,900 or 7.1 percent), wholesale and retail trade ($15,585,600 or 6.5 percent), petroleum products production ($14,945,300 or 6.2 percent), maintenance and repair construction ($8,908,300 or 3.7 percent), finance and insurance ($8,501,100 or 3.5 percent), and transportation and warehousing ($8,432,200 or 3.5 percent) sectors. These eight sectors would account for over 73 percent of the Oklahoma output impacts.

The indirect and induced output impacts picked up by input-output analysis are indicated very distinctively in Table XI, when compared to final demands in Table X. For example, the wholesale and retail trade, health, educational, and social services, and non-profit organizations, eating and drinking places, food and kindred products, and communications (except radio and TV) sectors had no final demand from the coal mining industry, but through indirect and induced effects, they show positive impacts in Table XI.

An increase of 25 percent in the normal level of demand for Oklahoma coal (e.g., Scenario II) would lead to an increase of 24.9 percent ($60,063,500) in the Oklahoma output of goods and services due to the coal mining industry. Thus, the total output generated directly, indirectly and induced by the coal mining activity considered under Scenario II would total $301,326,000 (in 1977 dollars).

Sectoral analysis of output shares under Scenario II indicates that the greatest proportion of Oklahoma output due to the level of coal mining activity encompassed by this scenario would be in the household, construction and mining machinery, real estate and rental, wholesale and retail trade, petroleum products production, maintenance and repair construction, finance and insurance, and transportation and warehousing sectors. These sectors would account for over 73 percent of the total Oklahoma output due to such a coal mining activity, as under Scenario I.

Sectoral analysis of output changes encompassed by Scenario II indicates that the greatest Oklahoma output change would be experienced by the household, construction and mining machinery, petroleum production products, real estate and rental, wholesale and retail trade, maintenance and repair construction, chemicals and selected chemical products, transportation and warehousing, and finance and insurance. These nine sectors would account for about 77 percent of the total output changes. Also, these sectors' output would grow by about 25 percent with respect to that output generated under Scenario I.

Oklahoma total output due to the coal mining activity encompassed under Scenario III would amount to $367,633,200 (in 1977 dollars). This output comprises an increase of $126,370,700 (52.4 percent) with respect to the output level generated under Scenario I. As in the previous scenarios, the major output contributions would come from those sectors listed when the output projections for such scenarios were discussed. Those eight sectors would account for about 73 percent of the total output. This share is similar to those of the other two scenarios.

Sectoral analysis of output changes encompassed by Scenario III when compared with Scenario I's output estimates indicates that the household sector would experience an increase in output of $41,338,100 (48.2 percent). This increase in output represents about 33 percent of the total output increase. The construction and mining machinery sector's output would increase by $11,464,700 (66.8 percent), which is equivalent to 9.1 percent of the total output change caused by an increase of 50 percent in the normal level of demand for Oklahoma coal. The real estate and rental and petroleum products production sectors' output would grow in $8,786,700 and $9,774,100, respectively. The sum of both output increments represents about 15 percent of the total change in Oklahoma output caused by Scenario III.

## Income Impacts

The purpose of this section is to present the income impacts caused by the coal mining activity consistent with each of the three scenarios considered in the study. The income impact associated with each sector (with the exception of the coal mining sector) was obtained by multiplying the output estimate by the corresponding income-output ratio, as explained in Chapter III. The income generated by the coal mining sector was obtained from the coal mine operators survey and corresponds to the wages and salaries paid to the coal mine workers by the coal mine companies. The Oklahoma income-output ratios for 1977 were obtained from Hirunruk (69). It was assumed that those ratios would prevail in the 1980's.

The income projections under each of the three scenarios, as well as the changes from Scenario I to Scenarios II and III are presented in Table XII. Those projections are expressed in 1977 dollars. However, the total income impact is also expressed in 1984 dollars, which was accomplished by using the same procedure used to convert total output.

The total income impact is represented by the total output impact on the household sector and stands for labor and proprietors' income. The total income impact caused by a coal mining activity level consistent with Scenario I would amount to $85,832,300 (in 1977 dollars). The greatest proportion of that income (47.5 percent) would come from the wages and salaries paid to the coal mine workers. However, the income generated directly, indirectly, and induced in the other sectors of the economy would surpass the former income source and amount to $48,850,400 (52.3 percent of the total income). The income share coming from the wholesale and retail trade sector ranks second in importance with 11.7 percent ($10,005,500), followed by the construction and mining machinery sector and the health, educational, and social services and non-profit organizations sector, with 6.1 percent ($5,259,400) and 5.5 percent ($4,703,700), respectively. The maintenance and repair construction, transportation and warehousing, finance and insurance, business services, automobile repair and services, petroleum products production, and natural gas production sectors would account for about 18 percent of the total income generated by a coal mining activity consistent with Scenario I.

The total Oklahoma income impact generated under Scenario II would total $105,133,600 (in 1977 dollars). The change in income with respect to Scenario I would reach $19,301,300, which represents an expansion of 22.5 percent.

## TABLE XII

## OKLAHOMA INCOME INDUCED BY THREE COAL DEVELOPMENT SCENARIOS BY INPUT-OUTPUT SECTOR ($1,000 IN 1977 PRICES)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 1. Livestock and livestock products | 220.3 | 288.0 | 67.7 | 383.0 | 162.7 |
| 2. Crops and other agricultural products | 145.8 | 184.8 | 39.0 | 299.9 | 84.1 |
| 3. Forestry and fishery products | 14.3 | 17.5 | 3.2 | 21.2 | 6.9 |
| 4. Agricultural, forestry and fishery services | 104.4 | 131.1 | 26.7 | 163.3 | 58.9 |
| 5. Iron and ferroalloy ores mining | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6. Nonferrous metal ores mining | 0.6 | 0.7 | 0.1 | 0.9 | 0.3 |
| 7. Stone and clay mining and quarrying | 29.5 | 37.6 | 8.1 | 46.2 | 16.7 |
| 8. Chemical and fertilizer mineral mining | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9. New construction | 168.6 | 201.1 | 32.5 | 218.7 | 50.1 |
| 10. Maintenance and repair construction | 2,262.2 | 2,857.4 | 595.2 | 3,529.9 | 1,267.7 |
| 11. Ordnance accessories | 0.4 | 0.5 | 0.1 | 0.6 | 0.2 |
| 12. Food and kindred products | 423.3 | 520.5 | 97.2 | 632.2 | 208.9 |
| 13. Tobacco manufacturers | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14. Broad and narrow fabrics, yarn and thread mills | 0.2 | 0.3 | 0.1 | 0.3 | 0.1 |
| 15. Miscellaneous textile goods and floor coverings | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 |
| 16. Apparel | 16.9 | 20.7 | 3.8 | 25.1 | 8.2 |

TABLE XII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 17. Miscellaneous fabricated textile products | 0.6 | 0.7 | 0.1 | 0.9 | 0.3 |
| 18. Lumber and wood products, except containers | 3.9 | 5.0 | 1.1 | 6.1 | 2.2 |
| 19. Wood containers | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20. Household furnitures | 2.8 | 3.5 | 0.7 | 4.2 | 1.4 |
| 21. Other furniture and fixtures | 0.4 | 0.5 | 0.1 | 0.6 | 0.2 |
| 22. Paper and allied products, except containers | 0.9 | 1.2 | 0.3 | 1.4 | 0.5 |
| 23. Paper board containers and boxes | 2.0 | 2.5 | 0.5 | 3.0 | 1.0 |
| 24. Printing and publishing | 116.0 | 142.8 | 26.8 | 172.7 | 56.7 |
| 25. Chemicals and selected chemical products | 815.3 | 1,083.0 | 267.7 | 1,309.5 | 494.2 |
| 26. Plastics and synthetic materials | 0.2 | 0.2 | 0.0 | 0.3 | 0.1 |
| 27. Drugs, cleaning and toilet preparations | 3.4 | 4.2 | 0.8 | 5.0 | 1.6 |
| 28. Paints and allied products | 0.4 | 0.5 | 0.1 | 0.7 | 0.3 |
| 29. Paving and roofing material | 146.3 | 179.8 | 33.5 | 217.9 | 71.6 |
| 30. Rubber and miscellaneous plastic products | 35.3 | 44.3 | 9.0 | 54.3 | 19.0 |
| 31. Leather tanning and finishing | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

TABLE XII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 32. Footwear and other leather products | 1.2 | 1.4 | 0.2 | 1.7 | 0.5 |
| 33. Glass and glass products | 32.8 | 40.0 | 7.2 | 48.9 | 16.1 |
| 34. Stone and clay products | 119.5 | 151.1 | 31.6 | 185.8 | 66.3 |
| 35. Primary iron and steel manufacturing | 63.1 | 84.5 | 21.4 | 104.0 | 40.9 |
| 36. Primary nonferrous metal manufacturing | 15.4 | 20.0 | 4.6 | 24.5 | 9.1 |
| 37. Metal containers | 0.4 | 0.5 | 0.1 | 0.6 | 0.2 |
| 38. Heating, plumbing and structural metal products | 86.7 | 110.3 | 23.6 | 134.7 | 48.0 |
| 39. Screw machine products and stamping | 3.3 | 4.1 | 0.8 | 5.1 | 1.8 |
| 40. Other fabricated metal products | 58.1 | 73.7 | 15.6 | 90.6 | 32.5 |
| 41. Engines and turbines | 0.4 | 0.5 | 0.1 | 0.6 | 0.2 |
| 42. Farm and garden machinery | 0.4 | 0.4 | 0.0 | 0.6 | 0.2 |
| 43. Construction and mining machinery | 5,259.4 | 7,126.2 | 1,866.8 | 8,770.3 | 3,510.9 |
| 44. Materials handling machinery and equipment | 337.4 | 447.7 | 110.3 | 559.5 | 222.1 |
| 45. Metal working machinery and equipment | 0.3 | 0.4 | 0.1 | 0.5 | 0.2 |
| 46. Special industry machinery and equipment | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 |

TABLE XII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 47. General industrial machinery and equipment | 12.2 | 16.3 | 4.1 | 20.1 | 7.9 |
| 48. Miscellaneous machinery, except electrical | 5.0 | 6.6 | 1.6 | 8.1 | 3.1 |
| 49. Office, computing and accounting machines | 3.9 | 5.4 | 1.5 | 6.4 | 2.5 |
| 50. Service industry machines | 9.3 | 11.2 | 1.9 | 14.0 | 4.7 |
| 51. Electric industrial equipment and apparatus | 3.1 | 4.1 | 1.0 | 5.0 | 1.9 |
| 52. Household appliances | 0.5 | 0.6 | 0.1 | 0.7 | 0.2 |
| 53. Electric lighting and wiring equipment | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 |
| 54. Radio, TV and communication equipment | 11.2 | 13.8 | 2.6 | 16.8 | 5.6 |
| 55. Electronic components and accessories | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 |
| 56. Miscellaneous electrical machinery and supplies | 0.4 | 0.5 | 0.1 | 0.6 | 0.2 |
| 57. Motor vehicles and equipment | 126.8 | 155.1 | 28.3 | 181.5 | 54.7 |
| 58. Aircrafts and parts | 18.1 | 22.5 | 4.4 | 28.0 | 9.9 |
| 59. Other transportation equipment | 63.7 | 67.5 | 3.8 | 72.5 | 8.8 |
| 60. Scientific and controlling instruments | 8.3 | 10.3 | 2.0 | 12.6 | 4.3 |

TABLE XII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 61. Optical, ophthalmic, and photo equipment | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 62. Miscellaneous manufacturing | 25.0 | 30.7 | 5.7 | 37.2 | 12.2 |
| 63. Transportation and warehousing | 2,021.4 | 2,513.3 | 491.9 | 3,176.7 | 1,155.3 |
| 64. Communication, except radio and TV | 1,289.6 | 1,592.2 | 302.6 | 1,934.5 | 644.9 |
| 65. Radio and TV broadcasting | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 66. Water supply and sanitary services | 371.9 | 456.3 | 84.4 | 557.0 | 185.1 |
| 67. Wholesale and retail trade | 10,005.5 | 12,313.8 | 2,308.3 | 14,950.0 | 4,944.5 |
| 68. Finance and insurance | 3,750.0 | 4,613.8 | 863.8 | 5,531.7 | 1,781.7 |
| 69. Real estate and rental | 850.2 | 1,048.7 | 198.5 | 1,271.1 | 420.9 |
| 70. Hotels and personal and repair services except auto | 770.0 | 946.4 | 176.4 | 1,146.1 | 376.1 |
| 71. Business services | 1,870.3 | 2,337.0 | 466.7 | 2,841.4 | 971.1 |
| 72. Eating and drinking places | 641.8 | 789.3 | 147.5 | 956.3 | 314.5 |
| 73. Automobile repair and services | 1,404.6 | 1,653.7 | 249.1 | 2,105.2 | 700.6 |
| 74. Amusements | 421.7 | 517.6 | 95.9 | 626.4 | 204.7 |
| 75. Health, educational and social services and non-profit organizations | 4,703.7 | 5,765.3 | 1,061.6 | 6,976.1 | 2,272.4 |
| 76. Federal government enterprises | 518.9 | 612.6 | 93.7 | 703.2 | 184.3 |
| 77. State and local government enterprises | 135.8 | 164.2 | 28.4 | 191.3 | 55.5 |

TABLE XII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 78. Petroleum products production | 2,829.3 | 3,760.6 | 931.3 | 4,679.6 | 1,850.3 |
| 79. Natural gas production | 1,529.7 | 1,922.4 | 392.7 | 2,353.1 | 823.4 |
| 80. Coal mining | 40,981.9 | 48,812.1 | 7,830.2 | 58,381.1 | 17,399.2 |
| 81. Electricity and hydropower | 553.5 | 686.7 | 133.2 | 833.5 | 280.0 |
| 82. Household | 402.5 | 493.1 | 90.6 | 596.4 | 193.9 |
| TOTAL | 85,832.3<br>(145,399.9)[a] | 105,133.6<br>(178,096.3)[a] | 19,301.3<br>(32,696.4)[a] | 127,170.4<br>(215,426.7)[a] | 41,338.1<br>(70,026.7)[a] |

[a] Totals expressed in 1984 price levels

A sectoral analysis of the income impacts under this scenario indicates that the income share coming from the coal mining activity would decrease by 1.3 percent, when compared to that share of Scenario I. The shares for the wholesale and retail trade, mining and construction machinery, and health, educational, and social services and non-profit organizations sectors would increase to 11.7, 6.8, and 5.5 percent, respectively.

A sectoral examination of income changes due to an increase of 25 percent in the normal level of demand for Oklahoma coal indicates that the greatest income change would be in the coal mining sector. The income coming from that sector would expand by about 19 percent. The absolute income change experienced by the wholesale and retail trade sector ranks second, with approximately 12 percent of the total income change, while the change in the construction and mining machinery sector ranks third, with about 10 percent of the total change.

An increase of 50 percent in the normal demand level for Oklahoma coal would cause the Oklahoma income generated directly, indirectly and induced by the coal mining activity to expand to $127,170,400. The absolute income increment measured with respect to Scenario I would amount to $41,338,100, which represents a relative increase of approximately 48 percent.

The sectoral distribution of income impacts under Scenario III closely follows the distributions under Scenario I and II. Fifteen sectors (coal mining, wholesale and retail trade, construction and mining machinery, health, educational and social services and non-profit organizations, finance and insurance, petroleum products production, maintenance and repair construction, transportation and warehousing, business services, natural gas production, automobile repair and services, communications, except radio and TV, chemicals and selected chemical products, real estate and rental, and hotels and personal and repair services) would account for nearly 94 percent of the total Oklahoma income due to a level of coal mining activity consistent with Scenario III.

A sectoral examination of the income changes for Scenario III measured with respect to Scenario I reveals that the income coming from the coal mining sector would increase by approximately 42 percent ($17,399,200). The income coming from the wholesale and retail trade sector would expand by nearly 49 percent; while that income from the construction and mining machinery sector would experience an increment of about 67 percent. The sectoral distribution of these income changes closely resembles that distribution for Scenario II.

## Employment Impacts

One of the main concerns of the study is the employment impact generated by the Oklahoma coal mining industry under three scenarios. Estimates of jobs created, as well as income produced, may be more meaningful and useful than output estimates.

The employment impact for each sector (with the exception of the coal mining sector) was obtained by multiplying the output estimate by the corresponding employment-output ratio, as described in Chapter III. The Oklahoma employment-output ratios for 1977 were gotten from Hirunruk (69). The effect of changes in labor productivity on employment were taken into consideration. Thus, annual growth rates in labor productivity by sector computed by Schreiner, Chang, and

Flood (77) were used to adjust those ratios up to 1985 and 1989. It was assumed that those growth rates would prevail during the 1980's. The Oklahoma coal mining employment estimates for each of the three scenarios considered in the study were gathered from the coal mine operators survey.

The employment estimates by sector for each coal mining development scenario, as well as the changes from Scenario I to Scenario II and III, are presented in Table XIII.

The total direct and secondary (indirect and induced) employment generated by the coal mining activity encompassed under Scenario I would reach 5,451 jobs. Of that figure, 26.3 percent (1,455 jobs) would be created in the coal mining industry. The number of jobs generated in the wholesale and retail trade sector would reach 1,038, which represents about 19 percent of the total employment caused by such a coal development scenario. The job creation in the household, hotels and personal and repair services, maintenance and repair construction, transportation and warehousing, automobile and repair services, construction and mining machinery, health, educational, and social services and non-profit organizations, eating and drinking places, finance and insurance, and business services sectors would range from 107 to 493 jobs. These ten sectors would account for about 43 percent of the total employment created under this scenario.

The projected employment generated by the coal development scenario of 6.25 million tons of coal per year would total 6,682 jobs. This figure is approximately 23 percent higher than the employment created under Scenario I. Absolute gains in employment would primarily be found in the coal mining, wholesale and retail trade,

## TABLE XIII

## OKLAHOMA EMPLOYMENT INDUCED BY THREE COAL DEVELOPMENT SCENARIOS BY INPUT-OUTPUT SECTOR (PERSONS PER YEAR)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 1. Livestock and livestock products | 48 | 54 | 6 | 72 | 24 |
| 2. Crops and other agricultural products | 46 | 49 | 3 | 62 | 16 |
| 3. Forestry and fishery products | 2 | 2 | 0 | 2 | 0 |
| 4. Agricultural, forestry and fishery services | 12 | 15 | 3 | 18 | 6 |
| 5. Iron and ferroalloy ores mining | 0 | 0 | 0 | 0 | 0 |
| 6. Nonferrous metal ores mining | 0 | 0 | 0 | 0 | 0 |
| 7. Stone and clay mining and quarrying | 2 | 3 | 1 | 4 | 2 |
| 8. Chemical and fertilizer mineral mining | 0 | 0 | 0 | 0 | 0 |
| 9. New construction | 11 | 13 | 2 | 14 | 3 |
| 10. Maintenance and repair construction | 151 | 182 | 31 | 224 | 73 |
| 11. Ordnance accessories | 1 | 1 | 0 | 1 | 0 |
| 12. Food and kindred products | 29 | 33 | 4 | 40 | 11 |
| 13. Tobacco manufacturers | 0 | 0 | 0 | 0 | 0 |
| 14. Broad and narrow fabrics, yarn and thread mills | 0 | 0 | 0 | 0 | 0 |
| 15. Miscellaneous textile goods and floor coverings | 0 | 0 | 0 | 0 | 0 |
| 16. Apparel | 2 | 2 | 0 | 3 | 1 |

## TABLE XIII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 17. Miscellaneous fabricated textile products | 0 | 0 | 0 | 0 | 0 |
| 18. Lumber and wood products, except containers | 0 | 0 | 0 | 1 | 1 |
| 19. Wood containers | 0 | 0 | 0 | 0 | 0 |
| 20. Household furnitures | 0 | 0 | 0 | 0 | 1 |
| 21. Other furniture and fixtures | 0 | 0 | 0 | 0 | 0 |
| 22. Paper and allied products, except containers | 0 | 0 | 0 | 0 | 0 |
| 23. Paper board containers and boxes | 0 | 0 | 0 | 0 | 0 |
| 24. Printing and publishing | 9 | 10 | 1 | 12 | 3 |
| 25. Chemicals and selected chemical products | 22 | 25 | 3 | 31 | 9 |
| 26. Plastics and synthetic materials | 0 | 0 | 0 | 0 | 0 |
| 27. Drugs, cleaning and toilet preparations | 0 | 0 | 0 | 0 | 0 |
| 28. Paints and allied products | 0 | 0 | 0 | 0 | 0 |
| 29. Paving and roofing material | 7 | 7 | 0 | 9 | 2 |
| 30. Rubber and miscellaneous plastic products | 2 | 2 | 0 | 3 | 1 |
| 31. Leather tanning and finishing | 0 | 0 | 0 | 0 | 0 |

TABLE XIII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 32. Footwear and other leather products | 0 | 0 | 0 | 0 | 0 |
| 33. Glass and glass products | 2 | 2 | 0 | 2 | 0 |
| 34. Stone and clay products | 8 | 9 | 1 | 11 | 3 |
| 35. Primary iron and steel manufacturing | 3 | 4 | 1 | 6 | 3 |
| 36. Primary nonferrous metal manufacturing | 1 | 1 | 0 | 1 | 0 |
| 37. Metal containers | 0 | 0 | 0 | 0 | 0 |
| 38. Heating, plumbing and structural metal products | 5 | 6 | 1 | 7 | 2 |
| 39. Screw machine products and stamping | 0 | 0 | 0 | 0 | 0 |
| 40. Other fabricated metal products | 5 | 6 | 1 | 7 | 2 |
| 41. Engines and turbines | 0 | 0 | 0 | 0 | 0 |
| 42. Farm and garden machinery | 0 | 0 | 0 | 0 | 0 |
| 43. Construction and mining machinery | 250 | 323 | 73 | 397 | 147 |
| 44. Materials handling machinery and equipment | 34 | 43 | 9 | 53 | 19 |
| 45. Metal working machinery and equipment | 0 | 0 | 0 | 0 | 0 |
| 46. Special industry machinery and equipment | 0 | 0 | 0 | 0 | 0 |

TABLE XIII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 47. General industrial machinery and equipment | 1 | 1 | 0 | 1 | 0 |
| 48. Miscellaneous machinery, except electrical | 0 | 0 | 0 | 0 | 0 |
| 49. Office, computing and accounting machines | 1 | 2 | 1 | 2 | 1 |
| 50. Service industry machines | 0 | 1 | 1 | 1 | 1 |
| 51. Electric industrial equipment and apparatus | 0 | 0 | 0 | 0 | 0 |
| 52. Household appliances | 0 | 0 | 0 | 0 | 0 |
| 53. Electric lighting and wiring equipment | 0 | 0 | 0 | 0 | 0 |
| 54. Radio, TV and communication equipment | 1 | 1 | 0 | 1 | 0 |
| 55. Electronic components and accessories | 0 | 0 | 0 | 0 | 0 |
| 56. Miscellaneous electrical machinery and supplies | 0 | 0 | 0 | 0 | 0 |
| 57. Motor vehicles and equipment | 6 | 7 | 1 | 8 | 2 |
| 58. Aircrafts and parts | 1 | 1 | 0 | 1 | 0 |
| 59. Other transportation equipment | 5 | 5 | 0 | 5 | 0 |
| 60. Scientific and controlling instruments | 0 | 1 | 1 | 1 | 1 |

TABLE XIII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 61. Optical, ophthalmic, and photo equipment | 0 | 0 | 0 | 0 | 0 |
| 62. Miscellaneous manufacturing | 2 | 3 | 1 | 3 | 1 |
| 63. Transportation and warehousing | 167 | 196 | 29 | 248 | 81 |
| 64. Communication, except radio and TV | 54 | 61 | 7 | 74 | 20 |
| 65. Radio and TV broadcasting | 0 | 0 | 0 | 0 | 0 |
| 66. Water supply and sanitary services | 12 | 13 | 1 | 16 | 4 |
| 67. Wholesale and retail trade | 1,038 | 1,210 | 172 | 1,469 | 431 |
| 68. Finance and insurance | 298 | 358 | 60 | 429 | 130 |
| 69. Real estate and rental | 70 | 84 | 14 | 101 | 31 |
| 70. Hotels and personal and repair services except auto | 142 | 171 | 29 | 207 | 65 |
| 71. Business services | 493 | 601 | 108 | 731 | 238 |
| 72. Eating and drinking places | 278 | 334 | 56 | 404 | 126 |
| 73. Automobile repair and services | 199 | 229 | 30 | 292 | 93 |
| 74. Amusements | 81 | 97 | 16 | 117 | 36 |
| 75. Health, educational and social services and non-profit organizations | 264 | 316 | 52 | 382 | 118 |
| 76. Federal government enterprises | 24 | 28 | 4 | 32 | 8 |
| 77. State and local government enterprises | 12 | 14 | 2 | 16 | 4 |

TABLE XIII (Continued)

| Input-Output Sector | Scenario I | Scenario II | Scenario II-Scenario I | Scenario III | Scenario III-Scenario I |
|---|---|---|---|---|---|
| 78. Petroleum products production | 20 | 23 | 3 | 28 | 8 |
| 79. Natural gas production | 42 | 47 | 5 | 57 | 15 |
| 80. Coal mining | 1,455 | 1,929 | 474 | 2,239 | 784 |
| 81. Electricity and hydropower | 26 | 29 | 3 | 35 | 9 |
| 82. Household | 107 | 128 | 21 | 155 | 48 |
| TOTAL | 5,451 | 6,682 | 1,231 | 8,035 | 2,584 |

business services, and construction and mining machinery sectors. These four sectors would account for about 67 percent of the total employment increase measured with respect to Scenario I.

As in Scenario I, the major job creation impacts are concentrated in the coal mining, wholesale and retail trade, and business services sectors. The percent distribution of employment by sector closely follows the distribution for Scenario I.

An increase of 50 percent in the normal demand level for Oklahoma coal would cause the Oklahoma employment generated directly, indirectly and induced by the coal mining activity to expand to 8,035 jobs. The employment increase measured with respect to Scenario I would total 2,584 jobs, which represents an expansion of about 47 percent. As in Scenario II, the greatest absolute increases would come from the coal mining, wholesale and retail trade, business services, and construction and mining machinery sectors.

It is important to point out that although not all sectors would realize increases in income and employment, none would experience declines. Several sectors are too small in terms of the share of the state economy to reflect the impacts resulting from the coal mining activity. Also, it is necessary to indicate that the importance of the service sectors may be underestimated as emphasis is focused on economic growth by means of manufacturing expansion. Thus, insufficient facilities in those sectors can thwart the growth of other sectors and consequently the growth of the entire state economy.

## Coal Mining Employment Analysis

The coal mining industry is an important employer in the Coal Region. The coal mining employment for the Coal Region by year and county is given in Table XIV. In 1976 the total coal mining employment for the region reached 1,086 jobs. It increased between 1976 and 1979, reaching a record high 1,827 jobs in the latter year. The increase in this period was about 68 percent. It decreased in 1980, 1982, and 1983. The coal mining employment in 1983 declined to 1,024 jobs. The coal mining employment trend has followed that trend of the coal production. This employment is important for the Coal Region where unemployment and underemployment are relatively high and where personal income is relatively low, as described in Chapter IV.

## Coal Mining Employment by Place of Work

The distribution of coal mining employment by place of work presented in Table XIV indicates that most of the employment is generated in Craig, Rogers, Haskell, Muskogee, LeFlore, and Okmulgee Counties. In 1976 these six counties accounted for over 86 percent of the total employment, while in 1983 they accounted for about 78 percent. The decrease in these counties' share is explained by the decrease in coal production in Okmulgee and Rogers Counties relative to that production of the former six counties.

## Coal Mine Workers Commuting Patterns

The distribution of the coal mining employment by place of residence could provide some support for the assumption that residents of the Coal Region are the main recipients of the employment in the coal industry. Information gathered from the coal mine operators survey for 1984 was used to determine the commuting patterns of the coal mine workers. The distribution of such workers by place of

TABLE XIV

COAL REGION EMPLOYMENT IN COAL MINING BY PLACE OF WORK,
BY YEAR AND COUNTY, 1976-1983

| County | 1976 | 1977[a] | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|
| Coal | -- | -- | -- | -- | -- | -- | -- | -- |
| Craig | 376 | -- | 579 | 502 | 419 | 409 | 379 | 269 |
| Haskell | 161 | -- | 184 | 271 | 317 | 304 | 289 | 104 |
| Latimer | 40 | -- | 2 | 63 | 51 | 47 | 39 | 35 |
| LeFlore | 136 | -- | 133 | 135 | 147 | 166 | 213 | 63 |
| McIntosh | -- | -- | 4 | 68 | 27 | 37 | 70 | 71 |
| Muskogee | 33 | -- | 37 | 95 | 154 | 102 | 106 | 104 |
| Nowata | 35 | -- | 34 | 41 | 28 | 105 | 31 | -- |
| Okmulgee | 47 | -- | 111 | 210 | 169 | 181 | 107 | 36 |
| Pittsburg | 57 | -- | 16 | 18 | 18 | -- | -- | 5 |
| Rogers | 182 | -- | 384 | 319 | 335 | 367 | 339 | 222 |
| Wagoner | 19 | -- | 59 | 88 | 61 | 86 | 123 | 99 |
| TOTAL | 1,086 | 1,793 | 1,564 | 1,827 | 1,726 | 1,804 | 1,698 | 1,024 |

[a] The figures by county for this year were inconsistent with the total employment reported.

Source: (12)

residence for 1984 is presented in Table XV. Out of 1,307 coal mine workers reported, 1,123 workers (85.9 percent) resided in the Coal Region Counties. About 2 percent commute to work from Kansas and Arkansas, while the rest were living in Tulsa, Mayes, Cherokee, Ottawa, and Sequoyah Counties.

The most prominent conclusion from Table XV is that there are very few coal mine workers commuting to work from outside the Coal Region. However, it is known that there is heavy out-commuting from the Coal Region Counties in almost every direction, except to the south. Workers who commute become a part of an area's economic base much as though they were employed in a basic industry located in the area itself. An increase in the coal mining activity would likely mean a smaller unemployment problem for the Coal Region if the additional jobs created by an expansion of such an activity are captured by those unemployed workers that remain in the region. A drop in the share of residents of the Coal Region out-commuting would be a drag on economic growth.

## Coal Transportation

Coal is shipped from Oklahoma by rail, barge, and truck. Barged coal leaves by way of the McClellan-Kerr Arkansas River Navigation System. The coal tonnage loaded for shipment by rail and truck and barge in Oklahoma during the period 1976-1983 is presented in Table XVI. About 95 percent of the total Oklahoma coal was shipped by rail and truck in 1976. Between 1976 and 1983 the percentage of coal transported by rail and truck decreased, reaching 75.0 percent in the latter year. This decrease was partially due to the increase in

TABLE XV

COAL MINING EMPLOYMENT BY PLACE OF RESIDENCE
FOR THE OKLAHOMA COAL REGION, 1984

| Place | Number of Workers | Percent |
|---|---|---|
| Coal Region | 1,123 | 85.92 |
| Cherokee County | 47 | 3.60 |
| Mayes County | 57 | 4.36 |
| Ottawa County | 17 | 1.30 |
| Sequoyah County | 20 | 1.53 |
| Tulsa County | 20 | 1.53 |
| Arkansas | 9 | 0.69 |
| Kansas | 14 | 1.07 |
| TOTAL | 1,307 | 100.00 |

TABLE XVI

BITUMINOUS COAL PRODUCED AND LOADED FOR SHIPMENT BY RAIL AND TRUCK AND BARGE IN OKLAHOMA, 1976-1983

| Year | Production (Tons) | Shipments by Rail and Truck[a] | | Shipments by Barge | | |
|---|---|---|---|---|---|---|
| | | Tons | % of Production | Tons | % of Production | % of All Commodities' Tonnage Transported on OK Segment of M-KARNS[b] |
| 1976 | 3,626,781 | 3,435,297 | 94.72 | 191,484 | 5.28 | 10.81 |
| 1977 | 5,346,654 | 4,908,339 | 91.83 | 438,315 | 8.17 | 15.95 |
| 1978 | 5,428,738 | 4,319,150 | 79.56 | 1,109,588 | 20.44 | 32.68 |
| 1979 | 4,791,767 | 3,999,660 | 83.47 | 792,107 | 16.53 | 21.85 |
| 1980 | 5,363;714 | 4,664,709 | 86.96 | 699,005 | 13.04 | 15.64 |
| 1981 | 5,728,461 | 4,445,911 | 74.71 | 1,282,552 | 25.29 | 26.29 |
| 1982 | 4,645,952 | 3,684,768 | 79.31 | 961,184 | 20.69 | 23.28 |
| 1983 | 3,635,890 | 2,725,372 | 74.95 | 910,518 | 25.05 | 23.27 |

[a]Coal loaded for shipment by rail and truck was calculated subtracting the amount transported by barge from the total amount of coal produced in the state.

[b]Oklahoma segment of the McClellan-Kerr Arkansas River Navigation System

Source: (12, 78)

transportation costs experienced in the rail and truck industries, which may have caused a shift toward the utilization of barge facilities, whose rates are relatively cheaper than those of the rail and truck industries.

Barge shipments of coal accounted for nearly 5 percent of the total Oklahoma coal shipped in 1976. However, barged coal tonnage has steadily increased to account for about 25 percent in 1983. Presently, coal is one of the most important commodities transported on the Oklahoma segment of the McClellan-Kerr Arkansas Navigation System. In 1976, the Oklahoma coal transported on the System represented about 11 percent of the total tonnage moved on such transportation way, while in 1983, it represented nearly 23 percent. Barged coal shipments in 1983 exceeded those of petroleum and wheat by 62,993 and 223,676 tons, respectively.

Information gathered from the coal mine operators survey indicates that in 1984, 34.9 percent of the Oklahoma coal was being shipped to its final destination by rail, 34.4 percent by truck, and 30.7 percent by barge. Also, it was found that five coal companies used only truck to transport their coal to its final destination, two used only barge, one used only rail, four used a combination of rail and truck and one used a combination of truck and barge.

## CHAPTER VI

## ENVIRONMENTAL AND SOCIAL WELL-BEING EFFECTS OF COAL MINING

Environmental and social well-being impacts are not easily measured. Everyone has a different idea of what is "good" and "bad" for the environment and for "social" man. While the preparation of an environmental impact assessment is not one of the major objectives of this study, it is important to examine the social and environmental effects of increased coal mining activity in the Coal Region.

A survey form for professionals residing in the Coal Region was developed and used to gather qualitative data on social and environmental factors relative to coal mining and reclamation. Professionals were asked to evaluate changes in social and environmental factors caused by an increase in coal mining activity in their counties of residence.

Three principal parameters, economic, environmental, and social, were used to analyze the well-being impacts of an increase in the coal mining activity. The components for each parameter were developed from the review of relevant coal mining impacts' literature. These components also are in accordance with the economic and environmental principles and guidelines for water and related land resources studies established by the U.S. Water Resources Council (79) and with the

Draft Environmental Impact Statement prepared for the Rural Abandoned Coal Mine Program (80).

Some of the adverse well-being impacts caused by an increase in the coal mining activity could be reduced or eliminated by the enforcement of the "Surface Mining Control and Reclamation Act PL 95-87." This act was passed to assist, complement and if necessary to replace state programs of surface mining and reclamation control (54). The key items of this law include: 1) separation of soil layers, preservation and replacement of top soil; 2) reclamation concurrent with strip mining; 3) retention of hydrologic balance in water quality and quantity; 4) fertilizer use and other soil amendments through soil tests to foster revegetation and soil productivity; 5) return of land to its pre-mining highest and best use or other use approved by the Office of Surface Mining; 6) post a performance bond of no less than $10,000 per mining permit, which may be forfeited in the event of failure to complete the reclamation plan; 7) provide ponds and fences as required; and 8) hold land out of production for at least five years after revegetation/reclamation, before releasing it to landowners. This law also provides for a timetable of mining engineering techniques and considerations to meet local, state and national applicable environmental protection performance standards. However, some professionals, including agronomists and Soil Conservation Service personnel, feel that the 1977 law is too stringent in some cases. One situation occurs when the topsoil is too thin and coal companies cannot afford to separate it from underlying strata. Another is the five year hold-back requirement after reclamation before the mined land can be released.

## Economic Well-Being Impacts

The economic impact parameter includes components affecting economic well-being. A summary of responses from the professionals survey on changes in economic well-being indicators that would be caused by an increase in the coal mining activity is presented in Table XVII. The words "increase" and "decrease" used in this table indicate the effect that an increase in the coal mining activity would have on a specific well-being indicator. The word "same" indicates that an increase in the coal mining activity is not likely to affect a particular indicator.

An increase in the Oklahoma mining activity is expected to generate substantial changes in the Coal Region's population. Sixty-five percent of the respondents expressed that the area population would increase, while 32 percent said that it would not change. The expected population increase would result from a migration increase into the study area and from decreased outmigration. Sixty-five percent of the professionals thought that the migration into the Coal Region would increase. None expected that it would decrease. Fifty-two percent of the respondents believed that migration out of the region would decrease, while 46 percent expected that it would remain the same.

It has been argued that the study region is characterized by a high outmigration of its young people because of lack of employment opportunities in the region. Twenty-five of the 52 respondents (48 percent) indicated that an increase in the coal mining activity would cause an increase in the number of young people (15-25 years of age) staying in the region, while exactly the same number pointed out that

TABLE XVII

SUMMARY OF RESPONSES FROM THE 52 PROFESSIONALS SURVEYED ON CHANGES IN ECONOMIC WELL-BEING INDICATORS CAUSED BY AN INCREASE IN THE COAL MINING ACTIVITY IN THE OKLAHOMA COAL REGION, 1984

| Indicator | Evaluation of changes in Economic Indicators | | |
|---|---|---|---|
| | Increase | Decrease | Same |
| Area Population | 34 | 1 | 17 |
| Migration into area | 34 | 0 | 18 |
| Migration out of area | 1 | 27 | 24 |
| Number of young people staying in area (15-25 years of age) | 25 | 2 | 25 |
| Population mix (men to women ratio) | 9 | 1 | 42 |
| Primary school enrollment | 34 | 0 | 18 |
| Secondary school enrollment | 29 | 0 | 23 |
| Agricultural employment | 1 | 12 | 39 |
| Mining employment | 52 | 0 | 0 |
| Manufacturing employment | 12 | 0 | 40 |
| Contract construction employment | 29 | 3 | 20 |
| Other types of employment | 19 | 3 | 30 |
| Employment of women | 12 | 2 | 38 |
| Regional employment | 32 | 0 | 20 |
| Land values | 28 | 7 | 17 |
| Acreage farmed in area | 1 | 16 | 35 |
| Quality of housing | 23 | 4 | 25 |
| Quantity of housing | 32 | 2 | 18 |
| Quality of roads | 9 | 30 | 13 |
| Quantity of roads | 14 | 2 | 36 |
| Modes of communication | 19 | 0 | 33 |
| Quality of public utilities | 12 | 3 | 37 |
| Quantity of public utilities | 22 | 2 | 28 |
| Quality of government services | 6 | 4 | 42 |
| Quantity of government services | 9 | 3 | 40 |
| Quality of community services | 11 | 6 | 35 |
| Quantity of community services | 19 | 3 | 30 |
| Property taxes | 28 | 3 | 21 |
| Other taxes | 32 | 0 | 20 |
| Average family income | 33 | 0 | 19 |
| Job opportunities for low income families | 36 | 2 | 14 |
| Cost of living | 27 | 0 | 25 |

it would not change. Regarding the population mix, most of the respondents (81 percent) did not anticipate any change in the men to women ratio.

An increase in the region's population and in the number of the people aged 15 to 25 is likely to cause an increase in primary and secondary school enrollment. Almost 65 percent of the respondents indicated that primary school enrollment would increase, while 52 percent of them expressed that secondary school enrollment would follow a similar trend. None of the professionals anticipated a decrease in primary and secondary school enrollment.

As presented in Chapter V, an increase in the coal mining activity will generate jobs in most sectors of the economy. About 75 percent of the professionals believed that agricultural employment would not change. About 77 percent of the respondents did not anticipate changes in manufacturing employment, while nearly 23 percent of them expected that it would increase. Over 55 percent of the professionals pointed out that contract construction employment would increase, while about 6 percent of them indicated that it would decrease. Technically, a decrease in this type of employment is unlikely due to the fact that the coal industry is an important buyer of the goods and services produced by the construction sector. Nearly 58 percent of the professionals believed that other types of employment would not change, while about 37 percent of them stated that it would increase. Also, 73 percent of the respondents did not anticipate an increase in the number of jobs for women. As expected, all of the respondents indicated that coal mining employment would increase. Finally, 32 of the 52 respondents stated that an increase in the coal mining activity would generate more jobs at the regional level.

It is important to indicate that it is unlikely that competition for labor will develop between the coal industry and the other sectors of the economy because of the high unemployment rates prevailing in the study region. Also, operators of small farms and ranches, who are underemployed and who feel a need for additional income, may take advantage of the new job opportunities generated by an increase in the coal mining activity.

Coal development is likely to affect land values, particularly those of the land with development potential at the first opportunity. Approximately, 54 percent of the respondents indicated that land values would increase, while 33 percent of them stated that they would not change.

Coal development unavoidably interferes with the short run use of land for farming and ranching. Strip mining temporarily takes away land from agriculture during mining operations and succeeding reclamation of spoil banks. The total land removed from agriculture at any given time depends upon many factors, including the amount of coal to be mined, thickness of the seams, location of the mines, timing of mining operations, and swiftness of reclamation. The amount of land taken out of agriculture at any particular time in the Coal Region probably will be relatively small, even at the maximum practical level of development. About 31 percent of the respondents contended that the acreage farmed in the region would decrease. However, nearly 67 percent of them expressed that an increase in the coal mining activity would not cause any change in the acreage farmed in the region.

A proxy of the acreage taken away from agriculture is presented in Table XVIII. The total acreage mined in the Coal Region by year and county for the period 1979-1983 was obtained from the coal mine operators survey and is presented in this table. The trend of this data closely follows that of the coal production. In 1979, 2,177 acres were mined in the Coal Region. The acreage increased by about 41 percent from 1976 to 1981 and decreased in the succeeding years, with only 1,896 acres being mined in 1983. The counties most impacted have been Craig and Rogers. In 1979, 31 and 11 percent of the total acreage mined were in Craig and Rogers Counties, respectively. The acreage mined in Craig County increased by 68 percent (by 457 acres) from 1979 to 1980. However, between 1980 and 1983 it decreased from 1,128 to 526 acres.

Information gathered from the coal mine operators survey indicates that 704 additional acres per year will be mined above the average acreage mined per year during the period 1980-1982 as a result of a 25 percent increase from the "normal" demand level for Oklahoma coal. These operators also indicated that 1,449 additional acres per year would be mined if the level of demand increases by 50 percent from the normal base.

An increase in the coal mining activity is not expected to cause a serious impact on housing-either in quality or quantity terms. Only a few of the respondents believed that both quality and quantity of housing would diminish. However, over 92 percent of the respondents indicated that housing quality and quantity would either increase or remain unchanged.

TABLE XVIII

TOTAL ACRES MINED IN THE OKLAHOMA COAL REGION, BY YEAR AND COUNTY, 1979-1983

| County | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|
| Coal | -- | -- | -- | -- | 11 |
| Craig | 671 | 1,128 | 946 | 615 | 526 |
| Haskell | 199 | 250 | 206 | 173 | 127 |
| Latimer | 112 | 126 | 121 | 132 | 95 |
| LeFlore | 80 | 108 | 193 | 229 | 153 |
| McIntosh | 31 | 6 | 40 | 80 | 136 |
| Muskogee | 69 | 137 | 202 | 140 | 121 |
| Nowata | 28 | 14 | 104 | 69 | -- |
| Okmulgee | 97 | 174 | 122 | 95 | 60 |
| Pittsburg | 16 | 23 | -- | -- | 7 |
| Rogers | 628 | 687 | 915 | 700 | 406 |
| Wagoner | 246 | 149 | 214 | 183 | 254 |
| TOTAL | 2,177 | 2,802 | 3,066 | 2,416 | 1,896 |

As indicated in Chapter V, a significant amount of coal mined in the region is moved by truck, either to its final destination or to the shipping points. This activity can significantly decrease the quality of the roads. In fact, over 57 percent of the respondents expressed that the quality of the roads in the Coal Region would decrease as a result of an increase in the coal mining activity. However, only about 27 percent of them indicated the quantity of the roads would increase.

Professionals were also asked about the impacts on various modes of communications, such as: roads, rail, air, and telephone. None of the respondents expected that the communication modes, in general, would be adversely affected by an increase in the coal mining activity.

Fluctuations in population changes due to changes in the size of the work force, lack of adequate local government funds, especially for capital expenditures, a shortage of professional management and planning capabilities, and absence of state and federal government assistance programs can seriously affect the quality and quantity of public utilities, and government and community services. However, according to most of the respondents, such problems are unlikely to occur in the Coal Region. They believed that both quality and quantity of such services would either remain the same or increase.

Coal mines are usually located near small towns. These locations incur an ad valorem or property tax obligation to the county and school district in which the mine is located. Also, municipal governments obtain tax revenues from sales taxes, property taxes on assessed valuation within town boundaries, and other charges and fees.

Thus, an increase in the coal mining activity in the region is likely to cause an increase in property taxes and other taxes. Over 53 percent of the respondents expected that property taxes would increase, while only 6 percent of them anticipated a decrease. Nearly 62 percent of the respondents indicated that other taxes also would increase. None expected that they would decrease.

As discussed in Chapter IV, the Coal Region has been characterized by high unemployment and underemployment rates, a high proportion of families living under the poverty threshold, and low per capita personal income. An increase in the coal mining activity may generate an improvement in the average family income and increase the job opportunities for low income families. Over 63 percent of the professionals questioned indicated that there would be an improvement in such indicators. None pointed out that average family income would decrease, while only two out of fifty-two respondents foresaw a decrease in the job opportunities for low income families.

About 52 percent of the professionals indicated that an increase in coal mining would cause increased demands for many goods and services and subsequently higher prices. They stated that this situation may hurt the elderly, those on fixed income, and others that would not be directly associated with the coal development. They also contended that these people would face increased costs, but would receive few income benefits. Thus, these professionals anticipated an increase in the cost of living. However, this phenomenon is unlikely to happen in the Coal Region since such a region has overcapacity of many goods and services.

## Environmental Well-Being Impacts

The environmental well-being impacts consider all of the factors that affect the environment, such as the quality of lakes, streams, and wildlife habitat. Stripping of the overburden from the coal seam is devastating to the environment at the surface area of the digging site. However, this disturbance covers only a limited area and is usually temporary. A summary of the responses from the professionals survey on changes in environmental well-being indicators caused by an increase in the coal mining activity is presented in Table XIX.

Stream and lake pollution from acid mine drainage and spoil bank erosion are major threats to water quality. Currently, coal mining operations are operated in such a way as to prevent acid mine water discharge. However, 67 percent of the professionals questioned expected that stream and lake pollution from acid mine drainage would increase as a result of an increase in coal mining activity in the study region.

Erosion is the major transporter of loose soils to streams and lakes. Soil is lost from mining operations, mine access roads, and coal haul roads. This erosion may increase sedimentation and subsesequently reduce the carrying capacity of waterways, clog reservoirs and destroy habitat for fish and other aquatic life. Approximately, 71 percent of the respondents pointed out that stream and lake pollution from spoil bank erosion would increase as a consequence of an increase in the coal mining activity.

The mechanical process of destruction and removal of vegetative cover temporarily degrades the air quality by increasing the dust in

TABLE XIX

SUMMARY OF RESPONSES FROM THE 52 PROFESSIONALS SURVEYED ON CHANGES IN ENVIRONMENTAL WELL-BEING INDICATORS CAUSED BY AN INCREASE IN THE COAL MINING ACTIVITY IN THE OKLAHOMA COAL REGION, 1984

| Indicator | Evaluation of Changes in Environmental Indicators | | |
|---|---|---|---|
| | Increase | Decrease | Same |
| Stream and lake pollution from | | | |
| a. acid mine drainage | 35 | 0 | 17 |
| b. spoil bank erosion | 37 | 1 | 14 |
| Dust pollution | 38 | 0 | 14 |
| Noise pollution | 37 | 0 | 15 |
| Other types of pollution | 26 | 0 | 26 |
| Traffic congestion | 33 | 0 | 19 |
| Acres of vegetation for wildlife | 5 | 32 | 15 |
| Safety of wildlife | 3 | 27 | 22 |
| Number of streams and lakes for aquatic habitat | 11 | 13 | 28 |
| Safety for aquatic habitat | 6 | 24 | 22 |
| Food and cover | 8 | 28 | 16 |

the area where coal mining is taking place. Coal mine operators periodically wet the haul roads and take other measures to reduce dust. However, about 73 percent of the respondents felt that dust pollution would increase as a result of an increase in the coal mining activity. Also, 71 percent of the professionals indicated that noise pollution would increase because of the increase in traffic and mine explosions. About 63 percent of the professionals pointed out that traffic congestion would increase. Opinions regarding other types of pollution were equally divided between those that thought the level of pollution would increase and those who felt that pollution would remain unchanged.

The loss of vegetation and overburden removal displaces and sometimes destroys wildlife in the area disturbed by coal mining. Wildlife is temporarily destroyed and the seasonal wildlife cycle is interrupted. Birds, many mammals, and game animals will leave safely. However, some animals are likely to be destroyed by coal mining activities. Also, drainage of streams, ponds, and swamps prior to coal mining may destroy some aquatic life, if proper precautions are not taken. As the land surface is reclaimed and the wildlife habitat is restored, equivalent animals will repopulate the mine area. Nevertheless, coal mining may cause habitat impairment or changes in the type of habitat. Some wildlife species may not be able to adjust to these changes. Thus, they do not return to the reclaimed lands. Generally, given enough time after restoration of such lands, the long term impact of coal mining is favorable because of the increase in the number of detention ponds, acres of vegetation, and food and cover.

An analysis of the responses regarding acres of vegetation for wildlife, safety for wildlife, safety for aquatic habitat, and food and cover indicates that between 46 and 62 percent of the respondents based their responses viewing mainly the short term impacts of coal mining, as they indicated that those indicators would be adversely affected by an increase in the coal mining activity in the study region. About 54 percent of the professionals indicated that the number of streams and lakes for aquatic habitat would remain unchanged, while 21 percent of them pointed out that they would increase.

## Social Well-Being Impacts

The social well-being impacts embrace those factors that could impinge on the social life of residents of the Coal Region. A summary of responses from the professionals survey on changes in social well-being indicators caused by an increase in the coal mining activity in the region is presented in Table XX.

An increase in the coal mining activity could lead to a decline in safety of human life. Car wrecks due to coal trucks, deteriorated roads, and increased dust could increase. About 42 percent of the professionals indicated that safety of human life would decrease due to the causes previously cited. Also, safety of human life may be affected by explosions in the coal mines. However, nearly 58 percent of the respondents expressed that such explosions would not alter safety of human life. The opinions of the rest of the professionals were equally divided between an increase and decrease of safety of human life due to explosions in the coal mines.

TABLE XX

SUMMARY OF RESPONSES FROM THE 52 PROFESSIONALS SURVEYED ON CHANGES IN SOCIAL WELL-BEING INDICATORS CAUSED BY AN INCREASE IN THE COAL MINING ACTIVITY IN THE OKLAHOMA COAL REGION, 1984

| | Evaluation of Changes in Social Indicators | | |
|---|---|---|---|
| Indicator | Increase | Decrease | Same |
| Safety of human life from car wrecks due to coal trucks, bad roads, and dust | 14 | 21 | 17 |
| Safety of human life from explosions | 11 | 11 | 30 |
| Quality of land-based recreation | 5 | 9 | 38 |
| Quantity of land-based recreation | 7 | 7 | 38 |
| Quality of water-based recreation | 5 | 10 | 37 |
| Quantity of water-based recreation | 9 | 7 | 36 |
| Conservation of | | | |
| a. Green space | 6 | 30 | 16 |
| b. Archaeological and historical sites | 2 | 15 | 35 |
| Attraction of tourists to area | 4 | 11 | 37 |
| Aesthetic value of the land | 3 | 29 | 20 |
| Private land ownership in area by local residents | 6 | 16 | 30 |
| Cultural values | 5 | 8 | 39 |

The development of energy resources must compete for land with other economically productive land uses such as grazing and row crops, with preservation and conservation, and with recreational uses. However, this competition is not likely to significantly affect the quality and quantity of land-based recreation in the Coal Region. Over 73 percent of the respondents pointed out that an increase in the coal mining activity would not cause changes in these two social well-being indicators.

The quality and quantity of water based recreation are unlikely to be negatively impacted by an increase in the coal mining activity if it is conducted in accordance with mining and environmental regulations. Regarding these indicators, more than 69 percent of the respondents said that they would remain unchanged.

Green space may be reduced in the short run as a consequence of an increase in the coal mining activity. However, in the long run as the land is reclaimed, green space may be significantly improved. An analysis of the responses concerning conservation of green space indicates that over 57 percent of the professionals looked only at the short run impacts as they pointed out that conservation of green space would decrease.

Artifacts of archaeological and historical sites may be destroyed by coal mining unless they are systematically investigated before being disturbed. Mining plans should include archaeological studies of the region. However, 67 percent of the professionals indicated that the conservation of archaeological and historical sites was unlikely to be affected by an increase in the coal mining activity in the study region. Only two out of fifty-two professionals pointed out that such indicator would be positively impacted.

In many cases, rehabilitation of mined lands can be and is being done so that the land is aesthetically more pleasing after being mined than before. Small ponds or lakes sometimes form as a result of mining, improving the appearance of the restored lands, which may cause an increase in the attraction of tourists to the region. However, 21 percent of the respondents indicated that the attraction of tourists would decrease. Also, over 55 percent of them pointed out that the aesthetic value of the land would decrease as a result of an increase in the coal mining activity. Apparently, these professionals thought only of the short run effects of coal mining and viewed the overburden removal as disruptive to the landscape and aesthetically repugnant, without paying attention to the reclamation process.

Private land ownership by residents of the Coal Region is also used as an indicator of social well-being. Coal mine operators used to buy, sell, trade, and lease land. Over 30 percent of the professionals expected that private land ownership by residents of the region would decrease as a result of an increase in the coal mining activity, while over 57 percent of them said that it would remain unchanged. The dramatic changes in cultural values experienced by some boomtowns, like Gillette, Wyoming, are unlikely to occur in the Coal Region. Over 84 percent of the professionals indicated that cultural values in the region would either remain unchanged or improve as a result of an increase in the coal mining activity.

Finally, it is worthwhile to state that the most difficult area of impact assessment concerns the well-being impacts of a coal development project. This dilemma arises not only from the absence of well-defined parameters by which well-being impacts can be measured, but also from the investigators' inability to attach positive or negative values to processes of well-being change. Thus, in discussing the well-being impacts of an increase in the coal mining activity in the Coal Region, any judgments regarding whether these effects are good or bad were avoided.

# CHAPTER VII

# FACTORS AFFECTING USE OF OKLAHOMA COAL AND POTENTIAL USERS

Fuel wood was the principal United States energy source until 1880. Coal was the major energy source from 1880 until 1950. From 1950 to the present time, petroleum and natural gas have been the leading energy sources. However, rising fuel prices and uncertainty with regard to appropriate supplies of petroleum and natural gas have increasingly turned the nation to alternate fuel sources. Thus, coal again has become an alternative energy source.

Electricity generation is the largest market for coal in the United States. The only present competition for coal in new electric power plants is nuclear energy. This situation originated from the Energy Supply and Coordination Act of 1974, which prohibits oil and natural gas burning in new power plants. Coal is also used in the paper, chemicals, petroleum stone, clay and glass, metals, coke manufacturing, cement manufacturing, and synthetics industries.

## Uses and Markets for Oklahoma Coal

Coal was the major energy source in Oklahoma before World War I. Presently, most Oklahoma coal is used in adjacent states. The main uses of Oklahoma coal are: electricity generation, coke manufacture, metallurgical use, and cement manufacture. Information obtained from the coal mine operators survey indicates that 43.5 and 6.8 percent of the coal currently being mined in Oklahoma is used for electricity generation and coke manufacture, respectively; while the rest is being used for industrial purposes.

Also, such information indicates that about 94 percent of the coal mined in Oklahoma is being used in domestic markets, but in other states. States to which coal is shipped include Arkansas, Illinois, Iowa, Florida, Kansas, Missouri, and Texas. Almost six percent of the coal mined in Oklahoma is being exported to Japan.

## Analysis of Coal Prices

In this section the Oklahoma coal price is evaluated in relation to the United States coal price. This evaluation will be done using f.o.b. prices at the mine. Also, delivered prices of coal received at the Oklahoma and United States coal-fired electric power plants will be compared, both in ton and Btu terms.

The United States f.o.b. price at the mine is the average market price from all coal producing states. Prices vary significantly from one state to another depending on quality of coal and distance to consuming states. Data published by the United States Energy Information Administration (81) for 1983 indicate that states with higher prices per ton include Alabama ($41.99 per ton), West Virginia ($35.45 per ton), Ohio ($33.38 per ton), Pennsylvania ($32.74 per ton) and Virginia ($31.86 per ton), while states with lower prices are North Dakota ($9.15 per ton), Texas ($10.49 per ton), Wyoming ($12.63 per ton), Montana ($14.22 per ton), and New Mexico ($18.00 per ton).

The average f.o.b. prices for Oklahoma and United States coal at the mine are presented in Table XXI. Oklahoma f.o.b. coal price at the mine steadily increased from $17.64 per ton in 1977 to $32.54 per ton in 1982, an increase of over 84 percent. However, in 1983 it decreased to $31.29 per ton. In the period 1977-1982, the United States coal price firmly increased by about 37 percent. Nevertheless, it decreased from $27.14 per ton in 1982 to $25.85 per ton in 1983, a decline of about 4 percent. The Oklahoma coal price was lower than the United States coal price in the period 1977-1978, while in the period 1979-1983 it was considerably higher than the United States coal price.

The average delivered prices of coal received at coal-fired electric power plants vary depending on the type of coal procurement, among other things. The utility company must decide how to obtain the coal. Coal procurement may be done by securing the coal on a long-term contract, or buying the coal on a "spot" basis.

The objective of a long-term contract is to bond buyer and seller together for mutual benefit. The most common long-term contract among the utility companies is the base-price-plus escalation contract. This type of contract begins with some base value per ton, then escalates the base over time to account for rising costs. It is favored by most utility companies because the risks are supposedly borne more equally by the buyer and the seller. The Oklahoma coal-fired electric power plants have secured their coal on a long-term contract basis. In 1983, 88.3 percent of the coal delivered to United States electric utility companies was obtained under long-term contract (85).

TABLE XXI

AVERAGE PRICES PER TON OF OKLAHOMA AND U.S. COAL, 1977-1983, DOLLARS F.O.B. AT THE MINE

| Year | Oklahoma Coal | U.S. Coal |
|---|---|---|
| 1977 | 17.64 | 19.82 |
| 1978 | 21.42 | 21.78 |
| 1979 | 25.72 | 23.65 |
| 1980 | 27.78 | 24.52 |
| 1981 | 32.53 | 26.29 |
| 1982 | 32.54 | 27.14 |
| 1983 | 31.29 | 25.98 |

Source: (3, 81, 82, 83, 84)

Coal procurement under a "spot" basis refers to the purchase of short-term coal supplies on the open market. About 11.7 percent of the coal delivered to United States electric utility companies was obtained through spot purchases (85). Electric utility companies use this method to avoid expenses of unnecessary large stockpiles, to cover peak coal demands, to take advantage of lower coal prices during certain periods, and to experiment with new coal sources.

Like most commodity markets, the spot coal market is volatile in terms of prices and quantities offered. Also, it is highly competitive. Some electric utility companies buy a major portion of their coal needs from the spot market, while others purchase little coal from such a market. Oklahoma coal-fired electric power companies buy no coal on a "spot" basis.

Average delivered prices of coal received at Oklahoma and United States coal-fired electric power plants are presented in Table XXII. Prices of coal received at United States electric utility companies are given on a contract basis and on a "spot" basis, while those for Oklahoma are presented on a contract basis. Delivered prices of coal received at Oklahoma electric utility companies increased from $20.02 per ton in 1979 to $29.73 per ton in 1983, an increase of about 49 percent. Information obtained from the Oklahoma coal-fired electric power plants survey indicates that coal transportation accounts for two-thirds to three-fourths of the cost of coal.

Delivered price of coal received at Oklahoma electric utility plants on a Btu basis increased from 115 cents per million Btu in 1979 to 173.3 cents per million Btu in 1983, an increase of about 51 percent. Also, it is worthwhile to point out that delivered price, in both ton and Btu terms, increased steadily in the period 1979-1983.

TABLE XXII

AVERAGE DELIVERED PRICES OF COAL RECEIVED AT OKLAHOMA AND U.S. ELECTRIC UTILITIES FOR STEAM PLANTS OF 50-MEGAWATT CAPACITY OR LARGER, 1979-1983

| Area | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|
| Oklahoma[a] | | | | | |
| $ per ton | 20.02 | 21.46 | 24.87 | 28.08 | 29.73 |
| per $10^6$ Btu | 115.00 | 123.40 | 145.30 | 164.60 | 173.30 |
| United States | | | | | |
| Contract prices | | | | | |
| $ per ton | 25.78 | 28.33 | 31.34 | 34.63 | 35.21 |
| per $10^6$ Btu | 122.00 | 134.80 | 151.30 | 165.10 | 167.80 |
| Spot prices | | | | | |
| $ per ton | 28.71 | 32.22 | 38.79 | 37.60 | 33.34 |
| per $10^6$ Btu | 124.40 | 137.30 | 164.40 | 160.80 | 149.80 |

[a] Average delivered prices of coal received at Oklahoma electric utility companies are contract prices.

Source: (85)

Contract delivered price of coal received at United States electric utility companies on a ton basis was higher than that at Oklahoma electric utility companies. United States' prices increased from $25.78 per ton in 1979 to $35.21 per ton in 1983, an increase of about 37 percent.

From 1979 to 1982, the contract delivered price of coal received at United States coal-fired electric power plants on a Btu basis was higher than that at Oklahoma's. It increased from 122 cents per million Btu in 1979 to 167.8 cents per million Btu in 1983, an increase of about 38 percent, which is 13 percent lower than the increase faced by Oklahoma electric power companies. Also, it is important to indicate that in 1983 the U.S. price was 5.5 cents lower than the price paid by Oklahoma coal-fired electric utility companies.

The spot delivered price of coal received at United States electric utility plants on a ton basis was greater than the Oklahoma price. It increased from $28.71 per ton in 1979 to $38.79 per ton in 1981 and decreased in 1982 and 1983, reaching $33.34 per ton in 1983. The percentage increase for the period 1979-1983 was close to 16 percent, which is 33 percent lower than the increase faced by Oklahoma electric utility companies.

From 1979 to 1983, the spot price paid by United States electric utility companies on a Btu basis was higher than that paid by Oklahoma electric utility companies. However, it was lower than the latter in 1983. The spot price for the United States increased from 124.4 cents per million Btu to 149.8 cents per million Btu in 1983, an increase of about 20 percent, which is 31 percent lower than the increase experienced by the price paid by Oklahoma coal-fired electric power companies. In 1983, the spot price for the United States on a Btu basis was 23.5 cents lower than the contract price for Oklahoma.

Finally, it is worthwhile to point out that the decline in spot prices was probably due to the decrease in electricity sales caused by the economic recession that began in 1981. Also, it is important to indicate that the increase in delivered prices paid by Oklahoma coal-fired electric power companies was mainly due to the increase in freight rates. According to the superintendents of the Oklahoma coal-fired electric power plants, freight rates have grown at a faster rate than the f.o.b. price of coal at the mines located in Campbell County, Wyoming. For instance, in 1977 Western Farmers Electric Cooperative paid $11.94 per ton to Burlington Northern to ship the coal from Gillette, Wyoming to Hugo, Oklahoma, while in 1983 it paid more than $23 per ton, an increase of about 93 percent.

## Oklahoma Coal-Fired Electric Power Plants: Users of Wyoming Coal

Currently, Oklahoma has nine coal-fired electric generating units in operation. Some characteristics of the Oklahoma coal-fired electric power plants are presented in Table XXIII. The total capability is 4,365 MW. The coal tonnage needed to operate these units at full capability is about 14.3 million tons per year. However, one more electric generating unit is under construction and expected to be completed in 1985. Thus, the total electric generation capability will increase to 4,885 MW, while the amount of coal needed will be approximately 16.3 million tons.

TABLE XXIII

SOME CHARACTERISTICS OF OKLAHOMA COAL-FIRED ELECTRIC POWER PLANTS, 1984[a]

| Characteristic | Generating Station | | | | | Total |
|---|---|---|---|---|---|---|
| | GRDA | Sooner (OG&E) | Muskogee (OG&E) | Northeastern (PSO) | Hugo (WFEC) | |
| Location | Choteau | Red Rock | Muskogee | Oologah | Ft. Towson | |
| Number of Units | | | | | | |
| Actual | 1 | 2 | 3 | 2 | 1 | 9 |
| Future | 2 | 2 | 3 | 2 | 1 | 10 |
| Capability (MW) | | | | | | |
| Actual | 490 | 1,030 | 1,545 | 900 | 400 | 4,365 |
| Future | 1,010 | 1,030 | 1,545 | 900 | 400 | 4,885 |
| Coal Use at Full Capability (million tons/year) | | | | | | |
| Actual | 1.6 | 3.0 | 4.5 | 3.6 | 1.6 | 14.3 |
| Future | 3.6 | 3.0 | 4.5 | 3.6 | 1.6 | 16.3 |

[a]The word "future" refers to the respective characteristics once the unit under construction is completed (e.g., GRDA has one unit operating at the present time, but one unit is under construction. Thus, GRDA will have two units operating in the near future).

The quantity of coal received, coal consumption, and stocks at Oklahoma electric utility plants for the period 1979-1983 are presented in Table XXIV. The quantity of coal received increased from 4,367,000 tons in 1979 to 10,671,000 tons in 1983, increasing about 144 percent. Coal consumption experienced a larger increase. It increased from 2,975,000 tons in 1979 to 12,042,000 tons in 1983, an increase of about 305 percent.

The Oklahoma coal-fired electric power plants have used only Wyoming coal in their generation operations to date. The superintendents of those plants contend that the boilers of the generating units were designed based on the characteristics of Wyoming coal. Also, Oklahoma coal has a higher sulfur content (2.00 percent) than Wyoming coal (0.4-0.7 percent), and the Oklahoma air quality regulations require sulfur dioxide emissions to be not greater than 1.2 pounds per million Btu.

Also, they indicated that the slagging characteristics of Wyoming and Oklahoma coal are different. Use of Oklahoma coal could cause detriments to boiler furnace surfaces. Thus, the rates of heat transfer and the heat balance for the boiler can be affected. Also, a change in the slagging characteristics of coal may cause corrosion, which leads to boiler tube failures and outages, and a shorter boiler life. Consequently, most Oklahoma coal-fired electric power plants are unable to use 100 percent Oklahoma coal in their generation operation. However, it may be feasible to use a blended mixture of 90 percent of Wyoming coal and 10 percent of Oklahoma coal, or even a higher ratio of Oklahoma coal.

TABLE XXIV

QUALITY OF COAL RECEIVED, COAL CONSUMPTION AND STOCKS AT OKLAHOMA ELECTRIC UTILITY PLANTS, 1979-1983 (1,000 TONS)

| Year | Quantity Received | Consumption | Stocks As of December, 31 |
|---|---|---|---|
| 1979 | 4,367 | 2,975 | 2,911 |
| 1980 | 7,883 | 5,752 | 5,157 |
| 1981 | 9,266 | 8,368 | 5,893 |
| 1982 | 10,723 | 11,096 | 5,407 |
| 1983 | 10,671 | 12,042 | 4,031 |

Source: (85)

## Oklahoma Coal-Fired Electric Power Plants: Potential Users of Oklahoma Coal

Oklahoma coal has a calorific value ranging between 12,000 Btu/lb to 13,000 Btu/lb. This value is about 4,000 to 5,000 Btu greater than the heat value of Wyoming coal. Also, Oklahoma coal has a lower moisture content than Wyoming coal (7.7 percent vs. 31 percent). These facts, together with an environment of increasing delivered prices of Wyoming coal received at Oklahoma coal-fired electric power plants, may stimulate Oklahoma electric utility companies to use a blended coal mixture of Wyoming and Oklahoma coal in the near future. Also, once the current coal contracts and transportation contracts signed by these companies expire, f.o.b. coal prices and transportation costs paid by such Oklahoma companies may increase drastically, thus making Oklahoma coal more competitive.

Currently, four of the five electric power plants surveyed are planning or conducting tests to determine how the performance of the boilers are affected by using a blended coal mixture. The superintendents of those plants said that Oklahoma sulfur's content is not the only concern. They argue that when using a coal mixture the fusion temperatures change, thus affecting the slagging characteristics within the boilers and surfaces downstream of the furnace boilers.

The ability to achieve a reliable coal mixture will be determined by the capabilities of the coal handling facility. At a minimum, separate identifiable storage piles would be required, with associated requirements for separate receiving and handling facilities to serve the individual coal piles. Thus, a cost study will also be necessary to determine the feasibility of a controlled blending scheme.

Regarding the modifications in the federal and state air quality regulations needed to stimulate use of a mixture of Oklahoma and Wyoming coal, all the superintendents of Oklahoma coal-fired electric power plants indicated that those regulations need to be changed to allow a higher level of sulfur dioxide emission. However, it is worthwhile to point out that environmental laws now require coal-burning facilities to have "scrubbers." Thus, it may be feasible to use such a mixture in those units that already have "scrubbers" and still be able to meet the federal and state air quality regulations.

Use of new technologies to desulfurize Oklahoma coal could enhance the possibilities of using such a coal in state electric utility plants. However, the superintendents of those plants argue that desulfurization processes, such as coal washing, may result in a product whose slagging characteristics are unknown. Also, those processes are costly and make Oklahoma coal less competitive. The superintendents said that their companies were not planning to use such processes in the near future.

The Grand River Dam Authority's electric generating Unit 2, which is now under construction, has been designed to use 33 percent of Oklahoma coal in its generation operation. Thus, GRDA plans to burn about 500,000 tons of Oklahoma coal and one million tons of Wyoming coal. This fact, together with the possibility of using 10 percent of Oklahoma coal in the rest of the state coal-fired electric power units, will significantly increase the level of demand for Oklahoma coal.

Finally, it is worthwhile to stress that even though the coal mining costs are higher in Oklahoma and subsequently its f.o.b. value is higher at the mine, its transportation costs obviously are lower than transportation costs for Wyoming coal. Thus, a change in the actual cost structure faced by the Oklahoma coal-fired electric power companies may induce them to view Oklahoma coal mining companies as a potential supplier in filling part of their coal needs.

# CHAPTER VIII

## SUMMARY AND CONCLUSIONS

In the past decade, energy prices on the world market rose dramatically, especially those of petroleum-based products. This situation has led to increased demands for development of domestic energy sources, both traditional (e.g., oil, gas, and coal) and alternative (e.g., nuclear, synfuel, wind, and solar). The United States has a very large reserve base of coal, estimated to be 482.9 billion tons in 1982. Such a reserve is being evaluated as one of the major sources for meeting the nation's energy needs. Even though Oklahoma's reserve base of coal comprises only 0.4 percent (1.6 billion tons in 1982), it represents a potential source of energy during a period of increasing concern for development of domes- tic energy supplies. Development of this coal reserve offers Eastern Oklahoma communities an opportunity for economic development. Historically, Eastern Oklahoma has been characterized by low per capita income and high unemployment and underemployment rates.

The general objective of the study was to identify the role of an expansion of the Oklahoma coal mining industry in promoting economic growth in a rural and economically depressed region in Eastern Oklahoma. Specific objectives of the study were to: 1) estimate the output, income, and employment impacts of the coal mining industry on the entire state economy, as well as on major industries providing intermediate inputs to such an industry under three different scenarios (e.g., initial level of demand for Oklahoma coal of 5 million tons per year, and increases of 25 and 50 percent from that level); 2) estimate commuting patterns of the Oklahoma coal mine workers; 3) examine the economic, social, and environmental well-being impacts of an increase in the coal mining activity; and 4) determine factors that prevent Oklahoma coal-fired electric power plants from using Oklahoma coal and the conditions that may induce those plants to use Oklahoma coal.

Three types of surveys were conducted to gather information needed for the study. Three groups of people were interviewed: professionals living in the 12-county study region (Coal Region), superintendents of the Oklahoma coal-fired electric power plants and coal mine operators. Also, secondary data were used to supplement the primary data and to reinforce the discussion of those topics considered in the study.

The output, income, and employment effects of three Oklahoma coal development scenarios on the state economy were estimated using an interregional input-output model. Such a model considers two regions, Oklahoma and Rest of U.S. It is closed with respect to households. Final demand vectors were developed from data on annual expenditures of the coal mine companies for each of the three scenarios. These vectors, as well as the changes in final demand for the second and third scenarios were applied to the input-output model to get output estimates for each scenario. The output estimates were later translated into income and employment estimates using income-output and employment-output ratios for Oklahoma.

The economic, social, and environmental well-being impacts of an increase in the coal mining activity were analyzed using qualitative information gathered through the use of the survey for professionals. They were asked to evaluate changes in economic, social, and environmental well-being factors caused by an increase in coal mining activity in their residence counties.

The survey of Oklahoma coal-fired electric power companies provided information needed to determine the factors that prevent Oklahoma coal-fired electric power plants from burning Oklahoma coal. Also, it furnished some data to evaluate the conditions that may induce those plants to use a mixture of Oklahoma and Wyoming coal.

## Economic Impacts of Coal Mining

The estimated total output generated by a coal development scenario consistent with a base demand level for Oklahoma coal of 5 million tons per year would amount to $241,625,000 (in 1977 dollars). An increase of 25 and 50 percent from the base demand level for Oklahoma coal would cause an increase of 24.9 percent ($60,063,500) and 52.4 percent ($126,370,700) in the Oklahoma output of goods and services generated directly, indirectly and induced by the coal mining industry, respectively.

The major input-output sectors affected by the Oklahoma coal mining industry under the three development scenarios would be the household, rental and real estate, construction and mining machinery, wholesale and retail trade, petroleum products production, maintenance and repair construction, finance and insurance, and transportation and warehousing. These eight sectors would account for over 73 percent of the Oklahoma output impacts.

Sectors experiencing greater output changes as a result of an increase of 25 and 50 percent from the base demand level for Oklahoma coal would be the household, construction and mining machinery, real estate and rental, and petroleum products production sectors. These four sectors would account for about 57 percent of the total change in Oklahoma output compared with the coal development scenario of 5 million tons per year.

The total income impact caused by a coal mining activity consistent with a level of demand of 5 million tons per year would total $85,832,300 (in 1977 dollars). An increase of 25 and 50 percent from the base demand level for Oklahoma coal would cause income to expand to $105,133,600 and $127,170,400, respectively. The income increases under the last two scenarios measured with respect to the first scenario represent an expansion of 22.5 and 48.0 percent, respectively.

The greatest proportion of income would come from the wages and salaries paid to the coal mine workers by the coal mine companies. However, the total income generated directly, indirectly and induced in the rest of the sectors of the economy would surpass the former income source and represent over 53 percent of the total income. The income received by the coal mine workers from the coal mine companies is the greatest impact. The income coming from the wholesale and retail trade, construction and mining machinery, health, educational and social services and non-profit organizations, maintenance and repair construction, transportation and warehousing, finance and insurance, business services, automobile repair and services, petroleum products production, and natural gas production sectors would follow in importance.

The total direct and secondary employment generated by a demand level for Oklahoma coal of 5 million tons per year would be 5,451 jobs, while an increase of 25 and 50 percent in the normal level of demand for Oklahoma coal would cause employment to expand to 6,682 and 8,035 jobs. Most jobs would be generated in the coal mining industry, followed by the wholesale and retail trade, business services, and construction and mining machinery sectors.

The coal mining employment in the Coal Region reached a record high of 1,827 jobs in 1979. However, it decreased to 1,024 jobs in 1983. This employment is important for the Coal Region where unemployment and underemployment are high.

The distribution of coal mining employment by place of work indicated that most of that employment was generated in Craig, Rogers, Haskell, Muskogee, LeFlore, and Okmulgee Counties. In 1983, these counties accounted for about 78 percent of the total coal mining employment in the Coal Region.

An analysis of the commuting patterns of the 1984 coal mining employment in the Coal Region indicated that about 86 percent of that employment was captured by workers residing in the region. The rest of the workers were either living in adjacent Oklahoma counties (12 percent) or commuting from Kansas and Arkansas (2 percent).

Oklahoma coal is an important commodity to the transportation sector, especially to the Oklahoma segment of the McClellan-Kerr Arkansas Navigation System. Presently, it is the most important commodity transported on the system. In 1983, barged coal shipments transported on the Oklahoma segment of the system reached 910,518 tons and exceeded those of petroleum and wheat by 62,993 and 223,676 tons, respectively.

## Social and Environmental Impacts of Coal Mining

Expanding coal development in the Coal Region would affect the economic, social, and environmental well-being of the study region. The most significant economic well-being changes would be: 1) a population increase, as a result of decrease in out-migration and increase in in-migration; 2) an increase in primary and secondary school enrollment; 3) an increase in employment opportunities in the contract construction and coal mining industries; 4) an increase in land values; 5) a deterioration in the quality of roads; 6) an increase in property taxes and other taxes; 7) an improvement in the average family income; and 8) an increase in job opportunities for low income families.

An increase in coal mining activity in the Coal Region would likely cause temporary adverse environmental effects. However, they would cover only a limited area. Some of the professionals interviewed anticipated only the short run impacts of coal mining, but not the long term effects. The most significant environmental well-being changes would be: 1) an increase in stream and lake pollution as a result of spoil bank erosion; 2) an increase in dust and noise pollution; 3) an increase in traffic congestion; 4) a decrease in acres of vegetation and safety for wildlife; 5) a decrease in safety for aquatic habitat; and 6) a decrease in food and cover.

Results from the survey for professionals indicated that most of them anticipated few changes in the social well-being indicators as a result of an increase in the coal mining activity. About 40 percent of the professionals believed that safety of human life would decrease as a consequence of car wrecks due to coal trucks, bad roads, and dust. Regarding green space conservation, approximately 58 percent of the professionals indicated that it would decrease. About 56 percent of the professionals interviewed pointed out that aesthetic value of the land would decrease. However, this decline in value may be only temporary.

## Oklahoma Coal and Coal-Fired Electric Power Plants

Oklahoma has nine coal-fired electric power generating units. However, none of these units have used Oklahoma coal in their generation operations. Superintendents of those power plants argued that such plants were designed to use Wyoming coal, which has different slagging characteristics from those of Oklahoma coal. Moreover, federal and state air quality regulations restrict the use of Oklahoma coal in those plants because of its higher sulfur content.

However, increasingly higher delivered price of Wyoming coal received at those power plants, which has increased at faster rates than that of the United States, has prompted officials of four Oklahoma coal-fired electric power plants to conduct tests to determine the feasibility of using a blended coal mixture of Oklahoma and Wyoming coal. Oklahoma coal has a higher heat value and less moisture than Wyoming coal. Also, the construction of the new GRDA electric generating unit capable of burning Oklahoma coal, and the expiration of existing coal contracts and transportation contracts signed by the Oklahoma electric utility companies can cause a significant increase in the demand level for Oklahoma coal.

## Study Limitations and Recommendations for Further Research

There are several limitations in the study, which arise from model assumptions and data limitations. The economic impact analysis was based on a static interregional input-output model. The most serious limitation of this type of model is that the technical coefficients and trade coefficients would remain fixed. However, for short run projections, this assumption is not a major limitation because fortunately technologies affecting the coal industry generally do not change rapidly in a short period of time.

Data limitations occurred since a vast amount of data are needed to build a model based on primary data. Time and funds prohibited the collection of primary data. Thus, the interregional input-output model used was developed for the base year 1977 using previous input-output tables and 1963 trade coefficients. Use of more recent data could lead to a model that better depicts interregional linkages between Oklahoma and Rest of U.S. Also, data limitations prevent the development of a model for the Coal Region. Thus, the output, income, and employment projections were developed for the entire state.

The study was conducted in a period of time characterized by a sluggish demand for Oklahoma coal and by conflicts between the U.S. Office of Surface Mining and the Oklahoma Department of Mines. These events may affect the number of coal companies that will remain in business. Thus, the pattern of expenditures of the coal companies staying in business may differ from the pattern existing when the study was conducted, which would lead to output, income, and employment estimates different from those estimates obtained in the study. However, the general magnitudes and directions of those estimates should tend to point out the importance of coal mining.

Further research is needed to alleviate the model and data limitations mentioned above. With more reliable data and additional information, new equations could be included in the model, making it suitable for evaluating the impacts of the surface mining regulations on coal mining, as well as for analyzing the environmental impacts of coal mining.

Although the study results appeared to be reasonable, a dynamic model would be more useful when long-term projections are made. However, development of a large-scale dynamic interregional input-output model requires a large amount of data, time and money, and the coordinated work of many specialists.

Finally, additional research is needed to determine how the cost structure of the Oklahoma coal-fired electric power plants will be affected by the use of a blended coal mixture of Oklahoma and Wyoming coal. Also, it will be interesting to determine whether consumers will be better off or worse off as a result of the use of such a coal mixture.

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APPENDIXES

SURVEY FORMS

APPENDIX A

SURVEY FORM FOR PROFESSIONALS

IN COAL AREAS

Confidential Confidential

1984 SURVEY FOR PROFESSIONALS IN COAL AREAS

ECONOMIC IMPACTS OF COAL MINING

Department of Agricultural Economics
Oklahoma State University
Stillwater, Oklahoma 74078

GENERAL INFORMATION

1. Name of Respondent______________________________
   Address______________________________
2. Professional position in the community______________________________
   ______________________________
3. Professional experience______________________________ years
4. Period of residence in the community______________________________ years

PERFORMANCE MEASURES

Based on your previous perception of the impacts of coal mining in your area, how would you evaluate changes in the measures of development in your county if coal mining increases in your county? Please check in the appropriate space.

| | Increase | Decrease | Same |
|---|---|---|---|
| 5. Population Characteristics | | | |
| a. Area population | _____ | _____ | _____ |
| b. Migration into area | _____ | _____ | _____ |
| c. Migration out of area | _____ | _____ | _____ |
| d. Number of young people staying in area (15-25 years of age) | _____ | _____ | _____ |
| e. Employment of women | _____ | _____ | _____ |
| f. Population mix (men to women ratio) | _____ | _____ | _____ |
| 6. Housing | | | |
| a. Quality of housing | _____ | _____ | _____ |
| b. Quantity of housing | _____ | _____ | _____ |
| 7. School enrollment | | | |
| a. Primary school | _____ | _____ | _____ |
| b. Secondary school | _____ | _____ | _____ |

| | Increase | Decrease | Same |
|---|---|---|---|
| 8. Land values | ____ | ____ | ____ |
| 9. General employment | | | |
| a. Agricultural employment | ____ | ____ | ____ |
| b. Mining employment | ____ | ____ | ____ |
| c. Manufacturing employment | ____ | ____ | ____ |
| d. Contract construction employment | ____ | ____ | ____ |
| e. Other types of employment | ____ | ____ | ____ |
| 10. Regional employment | ____ | ____ | ____ |
| 11. Acreage farmed in area | ____ | ____ | ____ |
| 12. Transportation/Communication | | | |
| a. Quantity of roads | ____ | ____ | ____ |
| b. Quality of roads | ____ | ____ | ____ |
| c. Modes of communication (road, rail, air, telephone) | ____ | ____ | ____ |
| 13. Public services | | | |
| a. Quality of public utilities | ____ | ____ | ____ |
| b. Quantity of public utilities | ____ | ____ | ____ |
| c. Quality of government services | ____ | ____ | ____ |
| d. Quantity of government services | ____ | ____ | ____ |
| e. Quality of community services | ____ | ____ | ____ |
| f. Quantity of community services | ____ | ____ | ____ |
| 14. Taxes | | | |
| a. Property taxes | ____ | ____ | ____ |
| b. Other taxes | ____ | ____ | ____ |
| 15. Income Distribution | | | |
| a. Average family income | ____ | ____ | ____ |
| b. Job opportunities for low income families | ____ | ____ | ____ |

| | Increase | Decrease | Same |
|---|---|---|---|
| 16. Quality of Environment Related Problems | | | |
| a. Stream and lake pollution | | | |
| 1. from mine drainage | ____ | ____ | ____ |
| 2. from spoil bank erosion | ____ | ____ | ____ |
| b. Dust pollution | ____ | ____ | ____ |
| c. Noise pollution | ____ | ____ | ____ |
| d. Traffic congestion | ____ | ____ | ____ |
| e. Other types of pollution | ____ | ____ | ____ |
| 17. Aquatic and terrestrial habitat | | | |
| a. Acres of vegetation for wildlife | ____ | ____ | ____ |
| b. Safety for wildlife | ____ | ____ | ____ |
| c. Number of streams and lakes for aquatic habitat | ____ | ____ | ____ |
| d. Safety for aquatic habitat | ____ | ____ | ____ |
| e. Food and cover | ____ | ____ | ____ |
| 18. Safety of human life and health | | | |
| a. Safety of life from car wrecks due to coal trucks, bad roads, dust | ____ | ____ | ____ |
| b. Security of life from explosions | ____ | ____ | ____ |
| 19. Recreation | | | |
| a. Quality of land-based recreation | ____ | ____ | ____ |
| b. Quantity of land-based recreation | ____ | ____ | ____ |
| c. Quality of water-based recreation | ____ | ____ | ____ |
| d. Quantity of water-based recreation | ____ | ____ | ____ |

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| | Increase | Decrease | Same |
|---|---|---|---|
| 20. Conservation | | | |
| a. Green space | ______ | ______ | ______ |
| b. Archaeological and historical sites | ______ | ______ | ______ |
| 21. Tourism Impacts (Attraction of tourists to area) | ______ | ______ | ______ |
| 22. Aesthetic value of the land | ______ | ______ | ______ |
| 23. Private land ownership in area by local residents | ______ | ______ | ______ |
| 24. Cost of living | ______ | ______ | ______ |
| 25. Cultural values | ______ | ______ | ______ |

26. In your opinion, what is the potential for coal mining in Eastern Oklahoma?

______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________
______________________________________________

27a. In your opinion, do you think that an expansion of the coal industry would be the best way to stimulate the economy of your area? ______________

______________________________________________
______________________________________________

b. If no, what do you think will be the best way to stimulate the economy of your area? ______________________________

______________________________________________
______________________________________________

DDB/ASMS/mcb

4-12-84

APPENDIX B

SURVEY FORM FOR SUPERINTENDENTS OF

COAL-FIRED ELECTRIC POWER PLANTS

Confidential Confidential

1984 SURVEY FOR SUPERINTENDENTS OF COAL-FIRED
ELECTRIC POWER PLANTS
ECONOMIC IMPACTS OF COAL MINING

Department of Agricultural Economics
Oklahoma State University
Stillwater, Oklahoma 74078

GENERAL INFORMATION

1. Name of Respondent______________________________
2. Address______________________________
3. County______________________________
4. Number of units____________________ Size of each unit______________
5. Name of company______________________________

ELECTRIC PLANT INFORMATION

6. How much coal does the plant use per year? ____________________tons
7. Where is the coal coming from? City and county____________________
   State____________________
   Coal Company____________________
8. Is the plant capable of burning Oklahoma coal (e.g., 10% of Oklahoma coal and 90% of Wyoming coal)? Yes_____ No_____
9. If not, what modifications would have to be made in the existing plant for it to be capable of burning this blended coal mixture (90%-10%)? __________
______________________________
______________________________
______________________________
10. Without modifying the existing plant, what could be done to use 10% of Oklahoma coal and still be able to meet the federal and state air quality regulations (cite any modifications in non-plant investment technology, e.g., washing of the coal, etc.)? ____________________
______________________________
______________________________
______________________________
______________________________

ADDITIONAL INFORMATION

11. What modifications, if any, in the federal and state air quality regulations are needed to motivate use of 10% Oklahoma coal blended with 90% Wyoming coal in your coal-fired power plant? ______________________________

12. In your opinion, what is the potential for coal mining in Eastern Oklahoma?

13. How much do you pay per ton of coal? (Please give f.o.b. price)

14. How much do you pay for the transportation of coal? (Please give cost in dollars per ton) ______________________________

DDB/ASMS/mcb

4-9-84

APPENDIX C

SURVEY FORM FOR COAL MINE OPERATORS

Confidential Confidential

1984 SURVEY FOR COAL MINE OPERATORS

ECONOMIC IMPACTS OF COAL MINING

Department of Agricultural Economics
Oklahoma State University
Stillwater, Oklahoma 74078

GENERAL INFORMATION

1. Privacy Code Number__________________

2. Is your coal company mining coal in any of the counties listed below? Please check.

| | | | |
|---|---|---|---|
| Coal _______ | Craig _______ | Haskell _______ | Latimer _______ |
| LeFlore _______ | McIntosh _______ | Muskogee _______ | Nowata _______ |
| Okmulgee _______ | Pittsburg _______ | Rogers _______ | Wagoner _______ |

MINE INFORMATION

3a. Estimated date(s) when mine began operation. Indicate it for each of the mine sites in the counties you have mentioned above.

| | Year | | Year |
|---|---|---|---|
| Coal | ______________ | Muskogee | ______________ |
| Craig | ______________ | Nowata | ______________ |
| Haskell | ______________ | Okmulgee | ______________ |
| Latimer | ______________ | Pittsburg | ______________ |
| LeFlore | ______________ | Rogers | ______________ |
| McIntosh | ______________ | Wagoner | ______________ |

b. What percentage of the coal currently being mined is on:

Company owned land______________
Land leased from private owners______________
Federal land leased through BLM______________

4. How many different coal mine sites does your company operate in the counties you listed above? Please check.

| | Number of Sites | | | | | |
|---|---|---|---|---|---|---|
| County | 0 | 1-3 | 4-5 | 6-7 | 8-9 | 10 and over |
| Coal | ____ | ____ | ____ | ____ | ____ | ____ |
| Craig | ____ | ____ | ____ | ____ | ____ | ____ |
| Haskell | ____ | ____ | ____ | ____ | ____ | ____ |
| Latimer | ____ | ____ | ____ | ____ | ____ | ____ |
| LeFlore | ____ | ____ | ____ | ____ | ____ | ____ |
| McIntosh | ____ | ____ | ____ | ____ | ____ | ____ |
| Muskogee | ____ | ____ | ____ | ____ | ____ | ____ |
| Nowata | ____ | ____ | ____ | ____ | ____ | ____ |
| Okmulgee | ____ | ____ | ____ | ____ | ____ | ____ |
| Pittsburg | ____ | ____ | ____ | ____ | ____ | ____ |
| Rogers | ____ | ____ | ____ | ____ | ____ | ____ |
| Wagoner | ____ | ____ | ____ | ____ | ____ | ____ |

5. Acres mined per year in each of the counties you checked above.

| | Year | | | | |
|---|---|---|---|---|---|
| County | 1979 | 1980 | 1981 | 1982 | 1983 |
| Coal | ____ | ____ | ____ | ____ | ____ |
| Craig | ____ | ____ | ____ | ____ | ____ |
| Haskell | ____ | ____ | ____ | ____ | ____ |
| Latimer | ____ | ____ | ____ | ____ | ____ |
| LeFlore | ____ | ____ | ____ | ____ | ____ |
| McIntosh | ____ | ____ | ____ | ____ | ____ |
| Muskogee | ____ | ____ | ____ | ____ | ____ |
| Nowata | ____ | ____ | ____ | ____ | ____ |
| Okmulgee | ____ | ____ | ____ | ____ | ____ |
| Pittsburg | ____ | ____ | ____ | ____ | ____ |
| Rogers | ____ | ____ | ____ | ____ | ____ |
| Wagoner | ____ | ____ | ____ | ____ | ____ |

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6. Tons of coal mined per year in each of the counties you listed above.

| | Year | | | | |
|---|---|---|---|---|---|
| County | 1979 | 1980 | 1981 | 1982 | 1983 |
| Coal | ______ | ______ | ______ | ______ | ______ |
| Craig | ______ | ______ | ______ | ______ | ______ |
| Haskell | ______ | ______ | ______ | ______ | ______ |
| Latimer | ______ | ______ | ______ | ______ | ______ |
| LeFlore | ______ | ______ | ______ | ______ | ______ |
| McIntosh | ______ | ______ | ______ | ______ | ______ |
| Muskogee | ______ | ______ | ______ | ______ | ______ |
| Nowata | ______ | ______ | ______ | ______ | ______ |
| Okmulgee | ______ | ______ | ______ | ______ | ______ |
| Pittsburg | ______ | ______ | ______ | ______ | ______ |
| Rogers | ______ | ______ | ______ | ______ | ______ |
| Wagoner | ______ | ______ | ______ | ______ | ______ |

7. Please give the labor requirements for your 1983 level of production and for a production level under the assumption that your share of the "normal" (1980-82) level of demand for Oklahoma coal (e.g. 5 million tons per year) were to be attained.

| | 1983 Level of Production | | Normal 1980-82 Level of Demand | |
|---|---|---|---|---|
| | Number | Months per yr. | Number | Months per yr. |
| Part-time employment | ______ | ______ | ______ | ______ |
| Full-time employment | ______ | ______ | ______ | ______ |

8. How many more acres and tons production per year could your company mine if the demand for Oklahoma coal increases from its "normal" (1980-82) base of 5 million tons per year by the following amounts:

| | Acres | Tons |
|---|---|---|
| a. 25 percent (to 6.25 million tons) | ____________ | ____________ |
| b. 50 percent (to 7.5 million tons) | ____________ | ____________ |

9. What is the average thickness of the coal seam for your potential mining sites (sites where you have leases)? ______________________________

______________________________________________________________

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10. How many new employees would be hired if the demand for Oklahoma coal increases from its normal base of 5 million tons by the following amounts?

a. 25 percent (to 6.25 million tons)

Part-time employees ____________

Full-time employees ____________

b. 50 percent (to 7.5 million tons)

Part-time employees ____________

Full-time employees ____________

11. Please estimate the expenditures (including investments) ($) per year in the State of Oklahoma for the following sectors for three assumptions: a) "normal" (1980-82) level of demand for Oklahoma coal (e.g. 5 million tons per year) b) increase of 25 percent in the demand for Oklahoma coal; and c) increase of 50 percent in the demand for Oklahoma coal.

| | Estimated Annual Expenditures | | |
|---|---|---|---|
| Fixed Costs | Normal demand level | 25% increase in demand | 50% increase in demand |
| 1. New construction (Company Hdqrs.) | ____________ | ____________ | ____________ |
| 2. Mining machinery | ____________ | ____________ | ____________ |
| 3. Materials handling machinery & equip. | ____________ | ____________ | ____________ |
| 4. Motor vehicles & equipment | ____________ | ____________ | ____________ |
| 5. Other transportation equipment | ____________ | ____________ | ____________ |
| 6. Office equipment (computers, milling machines, etc.) | ____________ | ____________ | ____________ |
| 7. Leases from Bureau of Land Management | ____________ | ____________ | ____________ |
| 8. Leases from land owners | ____________ | ____________ | ____________ |
| 9. Purchase of land from land owners | ____________ | ____________ | ____________ |

| Variable Costs | Normal demand level | 25% increase in demand | 50% increase in demand |
|---|---|---|---|
| 1. Chemicals & selected chemical products (including dynamite & fertilizer) | ______ | ______ | ______ |
| 2. Seeds (for revegetation) | ______ | ______ | ______ |
| 3. Petroleum refining & other related industries | ______ | ______ | ______ |
| 4. Electric services (utilities) | ______ | ______ | ______ |
| 5. Gas, water supply & sanitary services | ______ | ______ | ______ |
| 6. Finance & insurance | ______ | ______ | ______ |
| 7. Other business services (advertising, professional services - notary public, legal fees, accounting services) | ______ | ______ | ______ |
| 8. Vehicle & equipment repair & services | ______ | ______ | ______ |
| 9. Maintenance & repair construction | ______ | ______ | ______ |
| 10. Wages & salaries | ______ | ______ | ______ |
| 11. Transportation | ______ | ______ | ______ |
| 12. Reclamation costs | ______ | ______ | ______ |
| 13. Office of Surface Mines fines | ______ | ______ | ______ |
| 14. Oklahoma Department of Mines fines | ______ | ______ | ______ |
| 15. Permit Preparation | ______ | ______ | ______ |

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12. What are your other operating costs that are not included in the first column above (normal demand level)? ____________________

    ____________________________________________

13. What percentage of your annual non-payroll operating budget is spent in the counties where coal mining is taking place? __________

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MARKETING INFORMATION

14\. a. What percentage of the coal you sell is being used in domestic (U.S.) markets? ____________________

b. To what locations is it shipped? ____________________

____________________

15\. a. What percentage of the coal you sell is being shipped to foreign markets?

____________________

16\. End use of coal you are mining and percentage going to each use:

Electric power____________%

Coke ____________%

Industrial ____________%

17\. What percentage of the coal you mine is being shipped to its final destination by:

Rail ____________%

Truck____________%

Barge____________%

18\. How do you move the coal from the mine to the railroad? ____________________

____________________

____________________

19\. How do you move the coal from the mine to the port on the navigation channel?

____________________

____________________

____________________

20\. Do you own the trucks used to haul the coal? Yes____ No____

a. If yes, how many tons of coal can each truck haul per trip? __________

b. If no, who hauls your coal?

Name of company____________________

Address of company____________________

21\. Are you moving any coal to the Gulf Coast export points? Yes____ No____

If yes, how do you move it? Truck____ Rail____ Barge____

22\. What do you feel would be the effects of the coal fired power plants in Oklahoma blending 10% Oklahoma coal in their generation operations?

____________________

____________________

____________________

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QUESTIONS REGARDING YOUR EMPLOYEES

23. a. What percentage of your employees are residents of Oklahoma? __________
    b. What percentage of them live in the 12 counties listed in this survey form? ________________
    c. What percentage of them commute to work from other county(ies) not listed in this survey form? ________________
    d. Please specify county(ies) and percentage of residents of Oklahoma commuting from those counties which you employ.

| County | Percent |
|---|---|
| ______________________ | _________ |
| ______________________ | _________ |
| ______________________ | _________ |
| ______________________ | _________ |
| ______________________ | _________ |

24. a. What percentage of your employees are non-residents of Oklahoma? ______
    b. Please specify states and percentage of non-residents of Oklahoma commuting from those states which you employ.

| State | Percent |
|---|---|
| ______________________ | _________ |
| ______________________ | _________ |
| ______________________ | _________ |
| ______________________ | _________ |
| ______________________ | _________ |

DDB/ASMS/mcb

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VITA 2

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Doctor of Philosophy

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