18 B 9

PNL-3830 Vol. 9
UC-11

Volume 9: A Review of Socioeconomic Impacts of Oil Shale Development

Western Oil Shale Development: A Technology Assessment

February 1982

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness
under Contract No. DE-AC06-76RLO 1830

DOE Project Manager: G. J. Rotariu

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-3830 Vol. 9

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

NTIS Price Codes
Microfiche A01

Printed Copy

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
201-225	A010
226-250	A011
251-275	A012
276-300	A013

PNL-3830-9
LA-MS-8971
UC-11

Volume 9: A Review of Socioeconomic Impacts of Oil Shale Development

WESTERN OIL SHALE DEVELOPMENT:
A TECHNOLOGY ASSESSMENT

February 1982

Prepared for
the U.S. Department of Energy
Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness under
Contract DE-AC06-76RLO 1830

DOE Project Manager: G. J. Rotariu

Pacific Northwest Laboratory
Richland, Washington 99352

FOREWORD

The U.S. Department of Energy (DOE), Office of the Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness (EP), Office of Environmental Assessments, has been conducting technology assessments of the evolving energy technologies. The purpose of these is to evaluate in as quantitative a manner as possible the potential environmental, health, and socioeconomic impacts of each technology as it moves towards commercialization. The assessments identify where further information is needed, provide an analysis of potential environmental, health, and socioecomonic consequences of each technology, and define research and development (R&D) needed to ensure environmentally acceptable commercialization.

This is the final report of the Western Oil Shale Development Technology Assessment. We would like to express our appreciation to Drs. Darryl Hessel and Ira Levy of the Pacific Northwest Laboratory for their efforts in coordinating the work, to Dr. Hessel and Mr. Gabor Strasser for preparing this report, and to the entire team of participants listed in the Executive Summary and in the Appendix of Volume 1 of this report for conducting and reporting the major technical studies.

Dr. George J. Rotariu
Oil Shale Technology Assessment Project Manager
Technology Assessments Division

CONTENTS

LIST OF FIGURES

LIST OF TABLES

A REVIEW OF SOCIOECONOMIC IMPACTS OF OIL SHALE DEVELOPMENT

EXECUTIVE SUMMARY

The development of an oil shale industry in northwestern Colorado and northeastern Utah has been forecast at various times since early this century, but the comparatively easy accessibility of other oil sources has forestalled development. Decreasing fuel supplies, increasing energy costs, and the threat of a crippling oil embargo finally may launch a commercial oil shale industry in this region. Concern for the possible impacts on the human environment has been fostered by experiences of rapid population growth in other western towns that have hosted energy resource development. A large number of studies have attempted to evaluate social and economic impacts of energy development and to determine important factors that affect the severity of these impacts. These studies have suggested that successful management of rapid population growth depends on adequate front-end capital for public facilities, availability of housing, attention to human service needs, long-range land use and fiscal planning.

This study examines variables that affect the socioeconomic impacts of oil shale development. The study region is composed of four Colorado counties: Mesa, Moffat, Garfield and Rio Blanco. Most of the estimated population of 111 000 resides in a handful of urban areas that are separated by large distances and rugged terrain. We have projected the six largest cities and towns and one planned company town (Battlement Mesa) to be the probable centers for potential population impacts caused by development of an oil shale industry. Local planners expect Battlement Mesa to lessen impacts on small existing communities and indeed may be necessary to prevent severe regional socioeconomic impacts. Section II describes the study region and focuses on the economic trends and present conditions in the area.

The population impacts analyzed in this study are contingent on a scenario of oil shale development from 1980-90 provided by the Department of Energy and discussed in Sec. III. We recognize that the rate of development, the magnitude of development, and the technology mix that will actually take place remain uncertain. Although we emphasize that other energy and mineral resources besides oil shale may be developed, the conclusions reached in this study reflect only those impacts that would be felt from the oil shale scenario.

Socioeconomic impacts in the region reflect the uneven growth rate implied by the scenario and will be affected by the timing of industry developments, the length and magnitude of the construction phase of development, and the shift in employment profiles predicted in the scenario. The facilities in the southern portion of the oil shale region, those along the Colorado River and Parachute Creek, show a peak in the construction work force in the mid-1980s, whereas those facilities in the Piceance Creek Basin to the north show a construction peak in the late 1980s. Together, the facilities will require a large construction work force throughout the decade, with a total of 4800 construction workers required in 1985. Construction at the northern sites and second phase construction in the south will require 6000 workers in 1988. By 1990, the operation work force will increase to 7950. Two important characteristics of oil shale development emerge from the work force estimates: (1) peak-year construction work forces will be 90-120% the size of the permanent operating work force; and (2) the yearly changes in total work force requirements will be large, as much as 900 in one year at one facility.

To estimate population impacts on individual communities, we devised a population distribution method that is described in Sec. IV. Variables associated with the projection of population impacts are discussed and methodologies of previous assessments are compared. Scenario-induced population impacts estimated by the Los Alamos method are compared to projections of a model employed by the Colorado West Area Council of Governments. Oil shale development in the early decade, as defined by the scenario, will produce growth primarily in Battlement Mesa, Rifle, and Grand Junction. By 1985, the population of Battlement Mesa is projected to be 8500, the population of Rifle to increase to 8000, and the population of Grand Junction to increase by 2000 persons. Rangely's population is expected to double in this period, and Meeker will increase to 5200. By 1986, population pressures in the south will accelerate the growth rate of Meeker and Rifle and the entire region will experience a growth surge in 1988 induced by the second phase of construction at the oil shale sites. The regional population influx is estimated to increase to 40 600 by 1988 and drop to 38 300 by 1990. This drop reflects the decrease in construction activity at the close of the decade, as specified by the scenario.

Difficulties associated with the appraisal of public service needs are discussed in Sec. V. Conceptual problems in adopting adequacy standards are outlined and methodologies employed by other assessments are reviewed. Sources of disagreement over the cost of public facilities are also described. Using standards developed in 1979 by the Colorado Department of Local Affairs, we estimated that the public capital expenditures implied by the scenario-induced population growth would exceed $190 million over the decade. However, if the costs of public facilities in Battlement Mesa are internalized by the company, the total estimated capital costs would be $135 million. Use of a fiscal capacity model, developed by the State of Colorado, projected municipal revenue shortfalls in the early years of the scenario. These estimated shortfalls would be greatest in Meeker and in Rifle. These findings reaffirmed the conclusions of previous studies, which found that after the critical initial years of capital shortages, revenues would be sufficient to finance operating expenses of local government. Comprehensive fiscal planning, however, is handicapped by the multiple jurisdictions and uneven distribution of fiscal impacts.

Studies show work force estimates are strongly affected by worker living conditions, which directly affect worker productivity and turnover. Presently, new housing starts meet only current demand and thus would not accommodate a large influx of population. The lack of excess housing may be traced to a perception of risk by investors, who see uncertainties in national government and industrial development policies as stumbling blocks to the commercialization of oil shale. Provision of adequate housing for an oil shale "boom" may be handicapped not only by this perception of risk, but by lack of materials and construction labor, lack of mortgage capital, and inflationary land speculation. In Sec. VI, we discuss these obstacles to providing an adequate supply of housing and review problems associated with estimating housing demand. Intervention by industry or by the state or Federal Government may be necessary to guarantee housing availability. The scenario predicts approximately 8100 new households in the region by 1985 and 4600 more by 1990. If only half of these households enter new homes, we estimate that $261 million in mortgage capital (1980 dollars) will be needed by 1985 and a total of $404 million by 1990 (1980 dollars). The inability of local financial institutions to meet mortgage capital requirements may present a major impediment to oil shale commercialization. There may simply be no affordable place to live.

Social pressures associated with rapid population growth are well documented. Several groups of people are more vulnerable to negative impacts of rapid growth: wives of construction workers, the aged, people on fixed incomes, and children. Case studies have indicated that rapid population growth has been accompanied by rising crime rates, alcoholism, juvenile delinquency, child and spouse abuse, and a general increase in civil disorder. Nevertheless, well-planned and coordinated human services and programs designed to relieve stress, to provide a sense of community, and to integrate newcomers into the community may alleviate some of the negative consequences of rapid social change. In Sec. VII, we examine the factors that lead to social disruption and other negative consequences of social change in western rural communities. The importance of policy as a variable affecting social impacts is also discussed.

State and local governments have recognized the need to plan for growth although there continues to be much skepticism with regard to oil shale development. The planning activities of these governments are described in Sec. VIII. In addition to the development of comprehensive land use plans, local governments have developed mechanisms to define community needs. To prepare for growth that was forecasted for the late 1970s, local governments have obtained financial assistance from state and Federal programs to upgrade existing water and sewer systems, streets, schools, and other public facilities. Consequently, some of the communities in the region have excess capacity in their water and sewage treatment facilities and in their schools. There is a great reliance on external financial assistance for the construction of major public facilities that places heavy burdens of grantsmanship on local governments.

Section IX reviews the major conclusions of this study. These conclusions are summarized below.

- The scenario-induced population influx may cause as much as a five-fold population increase in some communities by 1990. The population of the four-county region, however, would increase by approximately one-third if oil shale development were the only growth factor.

- Large changes in construction work force requirements may increase the turnover in community residents although certain industry, national, state, and local government policies could attract a stable, permanent work force.

- The development of Battlement Mesa by industry is viewed as necessary to avoid severe strains on local community infrastructure and housing market.

- The counties in the region have different economic and tax bases and will be unevenly affected by oil shale development.

- Analysis of municipal fiscal capacity indicates that Meeker and Rifle would suffer the greatest capital shortfall.

- With the existing tax structure, local governments will continue to require external financial assistance for the construction and expansion of required public facilities.

- The supply of adequate housing probably will require intervention of industry and/or state and Federal Government.

- Alleviation of negative social impacts of stress and disruption of social patterns will require early implementation of programs designed to prevent these impacts as well as expansion of existing human services to meet new needs and increased demand.

- Uncertainty surrounding the schedule and magnitude of oil shale development defies timely implementation of growth management plans.

I. INTRODUCTION

Whereas much concern has been focused on the environmental impacts of energy development, the widely documented experiences of energy-impacted communities in the Rocky Mountain Region have drawn attention to the effects of energy development on the human factor. Indeed, disruptive socioeconomic impacts are anticipated to be a greater potential constraint to oil shale development, in particular, than any other environmental impact of that development.

Many attempts have been made to assess the magnitude of social and economic consequences of oil shale development. Some of these have drawn primarily from observations of communities that have hosted other types of energy development, such as coal mining, power plant construction, and uranium mining.[1] Other attempts have included the construction of methodologies that enable planners to forecast various types of impacts for a particular region or community.[2] Still others include (1) a collection of social, economic and land use data that are useful to planners,[3-5] (2) an evaluation and comparison of socioeconomic assessment methodologies and models,[2,6,7] and (3) annotated bibliographies of the vast amount of literature on socioeconomic assessment and its many analytical components.[8,9] However, there have been few attempts to provide a comprehensive and detailed analysis of social and economic impacts in a multicounty region, given a specific technology mix and energy development schedule. One important contribution was a very detailed impact assessment for northwest Colorado prepared by the Office of the Colorado Governor in 1974.[10]

Such an assessment would be handicapped by most of the problems common to previous assessments: lack of data or inconsistent reporting of data; lack of predictive methodology that is comprehensive, flexible, and sophisticated; the difficulty in estimating the interaction between variables and in accounting for the dynamic nature of socioeconomic impacts; and the uncertainties in government and industry policies.[2,6,7] Policy decisions certainly affect many of the variables in the analyses,[6,7,11] and as long as many government and industry policy options remain open, the impacts of oil shale development will be uncertain.

This study focuses on the northwestern region of Colorado, where development of an oil shale industry would probably produce the greatest impacts. The report's objective is to present sufficient descriptions of likely changes in socioeconomic variables to evaluate the need for mitigation in affected communities. There is a brief discussion of the study region, followed by the energy production scenario as it relates to this study. Given an energy production scenario and the accompanying employment data, the magnitude of socioeconomic impacts in cities and in the region as a whole depends on the temporal and geographical distribution of the population increases described in the scenario. For this reason, we have developed a method of population distribution that provides a temporal and geographic description of the scenario-induced population impacts. All other sections in this report have their specific analyses based on this distribution.

We must emphasize that the anticipated population growth in the study region as a result of oil shale development should not be viewed without regard for concurrent energy development of coal, oil, and gas resources. Our estimates may prove to be understated if concomitant energy resource development takes place within the study region.

Furthermore, we have restricted our study to six major towns in the region--Grand Junction, Rifle, Glenwood Springs, Meeker, Rangely, and Craig. Discussions with local government officials and industry representatives led us to include in our distribution considerations the town of Battlement Mesa, to be located near the confluence of Parachute Creek and the Colorado River.

Each section of the report presents socioeconomic variables, discusses their determination, and presents our results as applied to the given scenario. Wherever possible, we have attempted to present both qualitative and quantitative results.

II. THE STUDY REGION

The four-county region (Fig. 1) of northwestern Colorado contains abundant energy and mineral resources that have attracted the attention of the nation. Not only are the richest deposits of oil shale located in Rio Blanco and Garfield Counties, but vast coal reserves are contained in the Uintah formation that extends across those counties. In 1978, northwestern Colorado extracted 13.3 million tons of coal--94% of the state's total production that year. In addition to the oil shale and coal deposits, important oil fields

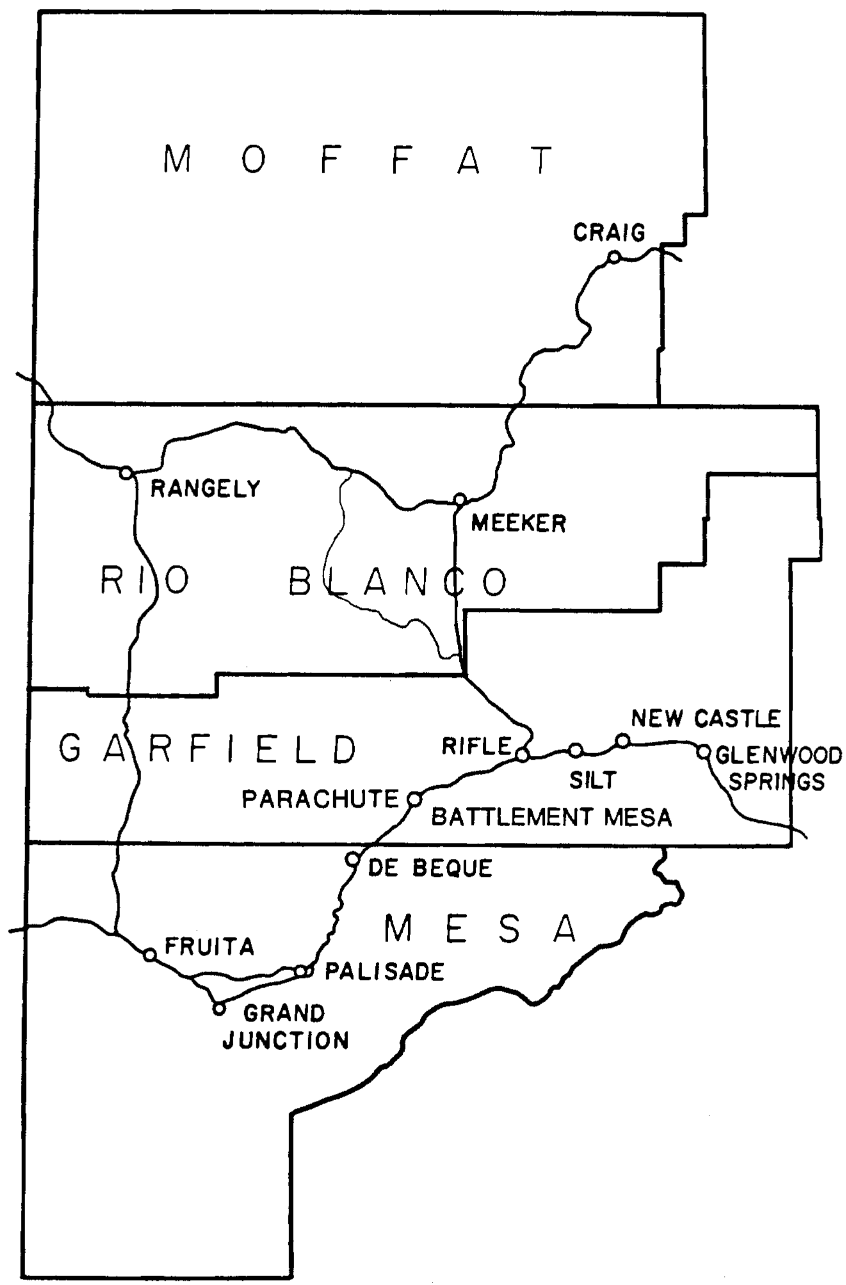

Fig. 1. Oil shale country, northwest Colorado.

are located in the central part of the region. The oil field discovered near Rangely, in western Rio Blanco County, was rapidly developed in the 1940s, and in 1978, produced 21.7 million barrels or 59% of the state's petroleum output. The oil field is now in the secondary recovery state. Natural gas resources also are located in the area, primarily in Rio Blanco and Moffat Counties, and exploratory drilling for natural gas increased sharply in 1979. Furthermore, nahcolite (a mineral that contains natural sodium bicarbonate) and dawsonite (a mineral that contains alumina) deposits are associated with the oil shale, and are expected to be developed by multimineral extraction ventures. Large-scale development of these energy and mineral resources would profoundly alter the economy of this region, which is already in transition. Mining has grown faster than any other industry in the past five years in Colorado, and this growth is paralleled in the study region. This energy development now leads all other sectors as the top income source in Moffat, Garfield, and Rio Blanco Counties (Table I).

Historically, the most important sector of the economy has been agriculture, which as recently as 1950 employed over 30% of the labor force in Garfield County, 26% in Rio Blanco, and 22% in Mesa County. However, agricultural employment has been declining steadily. In 1979, it was 4.5%, 9.7%, and 4.0% for these same three counties, respectively (Table II). In Garfield County, for example, financing problems and rapidly inflating land prices currently are forcing some cattle ranchers out of business. Orchards along the river in Mesa County are being sold out to developers. Although in terms of total personal income in 1978, farm income represented a little over 2% in Garfield County, 9.7% in Rio Blanco County, and less than 1% in Mesa County, agriculture is the principal land use in the region, with livestock grazing comprising about 90% of all land use.

While agriculture has declined in recent years, the recreational resources of the region have spawned a large and ever-growing tourist industry. Tourism has become especially important to the economy of Garfield County, which boasts a wide range of winter and summer sports activities and benefits from the increased tourist trade of adjacent Pitkin and Eagle Counties, to the south and east. Sports enthusiasts are drawn to Rio Blanco County for fishing, hunting, biking, and camping in the White River National Forest. The rangeland of the largest mule deer herd in Colorado spreads across the Piceance Creek Basin, making the region one of the best deer hunting grounds in the state. Tourist-related industries have grown to supersede agriculture as the principal source of income. Contract construction, retail trade, and services have grown as a result of the tourism. Employment growth of 12.7% for 1977-78 and 11% for 1978-79 has been attributed in part to the increasing importance of recreational activities in the region.[12] In terms of nonagricultural employment, this four-county region is one of the fastest growing of all planning regions in Colorado.

TABLE I

PERSONAL INCOME BY SELECTED MAJOR SOURCES, 1978

	Total Personal Income	Per Capita Income (Actual $)	Farming	Mining	Construction	Manufacturing	Transportation and Public Utilities	Retail Trade	Services	State and Local Government
Garfield County		7 574								
Thousands of $	148 194		3 504	17 196	11 462	2 054	10 231	15 643	15 795	9 747
% of Total			2.4	11.6	7.7	1.4	6.9	10.6	10.7	6.6
Mesa County		7 217								
Thousands of $	498 491		1 171	29 799	45 759	31 768	39 469	53 271	70 637	45 974
% of Total			0.2	6.0	9.2	6.4	7.9	10.7	14.2	9.2
Moffat County		9 166								
Thousands of %	100 628		5 281	26 858	22 276	--	3 262	8 205	4 190	4 838
% of Total			5.3	26.7	22.1	--	3.2	8.2	4.2	4.8
Rio Blanco County		8 940								
Thousands of $	46 005		4 485	13 365	3 617	605	3 295	2 117	1 873	5 530
% of Total			9.8	29.1	7.9	1.3	7.2	4.6	4.1	12.0
Colorado		8 116								
Thousands of $	21 673 092		363 203	678 271	1 310 309	2 831 623	1 432 337	1 904 728	2 916 516	2 020 269
% of Total			1.7	3.1	6.0	13.1	6.6	8.8	13.4	9.3

SOURCE: Colorado Manpower Review, XVII (4) (April 1980).

TABLE II

COUNTY RESIDENT LABOR FORCE, ANNUAL AVERAGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
						Garfield County				
Agricultural Employment	765	662	640	704	736	660	582	595	530	521
Nonagricultural Wage and Salary Employment[a]	4 949	5 236	5 988	6 606	7 200	7 506	8 122	8 164	8 975	9 311
All Other Employment[b]	806	857	945	999	1 048	1 102	1 167	1 187	1 295	1 320
Percent Unemployed	4.3	4.5	4.2	3.9	4.1	5.1	5.0	6.1	5.4	4.4
Total Labor Force	6 812	7 076	7 904	8 646	9 370	9 765	10 390	10 595	11 411	11 661
						Mesa County				
Agricultural Employment	2 198	1 902	1 840	2 027	2 113	1 893	1 791	1 707	1 519	1 495
Nonagricultural Wage and Salary Employment[a]	16 873	16 796	17 962	19 698	21 127	22 921	23 730	26 546	29 324	30 968
All Other Employment[b]	2 225	2 229	2 308	2 438	2 523	2 771	2 803	3 170	3 452	3 569
Percent Unemployed	4.7	5.1	4.6	3.9	4.0	4.7	4.6	4.2	3.6	3.4
Total Labor Force	22 349	22 063	23 164	25 155	26 849	28 948	29 696	32 802	35 571	37 310
						Moffat County				
Agricultural Employment	528	464	449	494	515	462	407	416	371	363
Nonagricultural Wage and Salary Employment[a]	1 838	1 937	2 091	2 312	2 488	2 864	3 525	4 267	5 381	5 714
All Other Employment[b]	454	483	505	540	558	651	790	970	1 211	1 260
Percent Unemployed	3.5	3.5	3.6	4.1	3.4	6.4	5.9	6.2	4.9	4.6
Total Labor Force	2 961	2 990	3 160	3 498	3 687	4 247	5 019	6 027	7 322	7 688
						Rio Blanco County				
Agricultural Employment	435	381	369	405	424	380	336	343	305	301
Nonagricultural Wage and Salary Employment[a]	1 379	1 361	1 216	1 278	1 333	1 308	1 318	1 492	1 831	2 263
All Other Employment[b]	329	328	279	283	286	285	282	326	392	483
Percent Unemployed	4.2	3.6	3.2	3.4	2.7	3.2	3.2	2.6	2.2	1.6
Total Labor Force	2 237	2 147	1 926	2 035	2 100	2 039	2 000	2 219	2 584	3 095
						Study Region				
Total Labor Force	34 359	34 276	36 154	39 334	42 006	44 999	47 105	51 643	56 888	59 754

[a]Establishment employment adjusted for multiple job holding and commuting.
[b]Includes self-employed, unpaid family and domestic workers.

SOURCE: Colorado Manpower Review
Division of Employment and Training
Colorado Department of Labor and Employment

The top 10 sources of personal income are shown in Table III. The importance of the energy industry to the region is immediately apparent. Mining is the top source of personal income in Garfield, Moffat, and Rio Blanco Counties. As noted in Table I, mining income in Rio Blanco County was greater in 1978 than the combined wages of farm and government workers. In addition, average per capita income in both Moffat and Rio Blanco Counties exceeded the state average. Mining and construction were far greater sources of income in Moffat County than any other activity, constituting one-half of all income in the county. Construction income was boosted by the construction needs of a coal-fired power plant and housing for the workers. The tourist trade in Garfield County is reflected in the high rank of services, retail trade, and construction sectors.

The region is rural, sparsely populated (Table IV), and contains only a handful of communities larger than a few thousand people. In the 1970s, population in many of these communities was mainly stable, with only minimal growth (Table V). In recent years, however, the metropolitan area of Grand Junction has experienced rapid growth that local government has had difficulty managing. The rapid growth has been accompanied by a proliferation of special districts to provide services to residents. In addition, over 100 housing subdivisions are under development outside of the city limits. There are now an estimated 50 000 people in the metro area. Grand Junction is the commercial and distribution center of the region, providing medical, education, banking, and other services to surrounding counties. The city is served by air, rail, bus, and major highway transportation. As a regional supply and service center, Grand Junction is certain to see continued rapid growth associated with development of the oil shale industry.

West of Grand Junction, along the Colorado River on Interstate Highway I-70, are DeBeque, Parachute, and Rifle. Because many of DeBeque's residents work in Grand Junction or Rifle, DeBeque lacks its own industrial or commercial tax base. Parachute, an agricultural community located at the entrance to the Parachute Creek Basin, is the site of several proposed commercial oil shale facilities. The town has a large number of retired persons on fixed incomes and one of the highest mill levies in the region. The growth of the town is limited by land and water restraints.[4] The site of the proposed new town of Battlement Mesa is across the river from Parachute.

TABLE III

RANK OF ECONOMIC SECTORS AS SOURCE OF PERSONAL INCOME

Rank	Total Colorado	Garfield County	Mesa County	Moffat County	Rio Blanco County
1	Services	Mining	Services	Mining	Mining
2	Manufacturing	Services	Retail trade	Construction	Government
3	State and local government	Retail trade	Government	Retail	Farm
4	Retail trade	Construction	Construction	Farm	Construction
5	Transportation and public utilities	Transportation and public utilities	Transportation and public utilities	Government	Transportation and public utilities
6	Construction	Government	Manufacturing	Services	Retail trade
7	Wholesale trade	Federal civilian	Mining	Transportation and public utilities	Services
8	Finance, insurance, and real estate	Finance, insurance, and real estate	Wholesale trade	Wholesale trade	Federal civilian
9	Federal civilian	Wholesale trade	Federal civilian	Federal civilian[a]	Finance, insurance, and real estate
10	Mining	Farm	Finance, insurance, and real estate	Finance, insurance, and real estate	Wholesale trade

[a]Nonmilitary federal worker.

SOURCE: Colorado Manpower Review XVII (4) (April 1980).

TABLE IV

POPULATION DENSITY PER SQUARE MILE[a]

County	1960	1970	1977	Area (Square Miles)
Garfield	4.0	4.9	6.3	2996
Mesa	15.4	16.5	20.4	3301
Moffat	1.5	1.4	2.2	4743
Rio Blanco	1.6	1.5	1.6	3263

[a]Based on Census data, US Bureau of the Census.

TABLE V

POPULATION CHANGES, 1970-1979

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Garfield County: Total	14 821	15 447	15 945	16 445	17 177	17 912	18 403	18 976	19 605	20 251
Carbondale	726	783	829	875	1 002	1 128	1 552	1 685	1 965	2 282
Glenwood Springs	4 106	4 208	4 289	4 370	4 861	5 351	4 092	4 090	3 847	3 604
Parachute	270	269	268	267	286	304	366	382	412	442
New Castle	499	529	552	576	658	740	539	545	514	483
Rifle	2 150	2 110	2 078	2 046	2 031	2 016	2 235	2 248	2 288	2 320
Silt	434	462	484	506	554	608	817	878	1 008	1 147
all unincorporated	6 636	7 086	7 445	7 805	7 785	7 765	8 802	9 148	9 571	9 973
Mesa County: Total	55 374	55 659	56 689	57 718	60 097	62 474	65 560	67 347	69 760	72 263
Collbran	225	213	204	195	203	211	286	296	331	370
DeBeque	155	158	161	163	220	276	253	268	285	303
Fruita	1 822	1 868	1 904	1 941	2 043	2 145	2 276	2 348	2 437	2 526
Grand Junction	24 105	24 703	25 182	25 661	26 731	27 801	25 323	25 452	24 955	24 425
Palisade	874	894	910	926	905	883	1 021	1 045	1 095	1 146
all unincorporated	27 193	27 823	28 328	28 832	29 995	31 158	36 401	37 938	40 657	43 494
Moffat County: Total	6 525	6 650	6 751	6 850	8 062	9 274	9 888	10 438	11 262	12 151
Craig	4 629	4 578	4 538	4 497	5 575	6 653	6 412	6 765	7 103	7 446
Dinosaur	247	255	261	267	289	311	336	351	369	388
all unincorporated	1 649	1 817	1 952	2 086	2 198	2 310	3 150	3 322	3 790	4 317
Rio Blanco County: Total	4 842	4 909	4 961	5 015	5 182	5 348	5 075	5 112	5 088	5 064
Meeker	1 597	1 674	1 736	1 798	1 892	1 985	1 823	1 859	1 850	1 840
Rangely	1 591	1 599	1 604	1 610	1 701	1 792	1 843	1 883	1 933	1 982
all unincorporated	1 654	1 636	1 621	1 607	1 589	1 571	1 409	1 370	1 305	1 242

SOURCE: Colorado Demographer's Office, estimates.

Located at the junction of I-70 and State Highway 13 is Rifle, an area trade center since the turn of the century. Rifle continues to serve a large surrounding area with retail and educational services, medical care, and entertainment. The town has enjoyed growth in tourism-related industries in recent years, especially in services and trade, which have become the number one and two employment sectors. Agriculture, particularly cattle ranching, nevertheless, is an important local concern. Cattle ranching interests continue to be prominently represented in local government.

Glenwood Springs, to the east of Rifle, has always been a resort town and continues to grow from local tourism and the trade of tourists on their way to resorts in adjacent counties. This city is the commercial heart of eastern Garfield County and anticipates continued economic growth stimulated by recreational activities and energy development other than oil shale; in particular, coal development in Pitkin County. Evidence of this expectation is that most of the planned subdivisions in Garfield County are located east of Glenwood Springs.

Lying between Glenwood Springs and Rifle are Silt and New Castle. Both of these small agricultural communities depend on Rifle or Glenwood Springs for many retail and service facilities. The amount of growth these communities can bear, however, is limited by geographical constraints.

Approximately 40 miles north of Rifle, Meeker is the only urban area in eastern Rio Blanco County. It is primarily an agricultural community and has historically served as a supply center to ranches in the area. The top employment sectors in the town are agriculture, mining, and government. Meeker has the lowest mill levy of any community in the region yet provides its residents with a broad range of services. Because the coal fields of the Axial Basin are located only a few miles to the north, Meeker anticipates a substantial amount of growth from both coal and oil shale development, and has adopted a strict policy of orderly growth management.

Located about 50 miles west of Meeker, Rangely is the only other urban area in Rio Blanco county. Now over 2000, Rangely's population in 1946 was 20. The oil boom has left this town with a population whose median age is the lowest in the region and whose prodevelopment stance welcomes a new source of economic growth as the life of the oil field draws to a close.

The second largest city in the four-county region is Craig, located in Moffat County about 50 miles north and east of Meeker. The power plant construction of the last few years has brought a population boom to Craig. The city now possesses many new public facilities, new housing, has more industrial and rail facilities than any other city in the region except Grand Junction and provides services to a large surrounding region. Craig expects further population and economic growth in response to development of the area's energy resources.

III. THE DOE OIL SHALE SCENARIO

Oil shale development is projected by the Department of Energy (DOE) scenario to occur in Colorado, Utah, and, to a small extent, in Wyoming. Eight of the fourteen oil shale facilities in the scenario, representing 90% of the shale oil production predicted by 1990, are located in Colorado. In this analysis, we have included these eight Colorado facilities and two Utah facilities. These ten facilities, representing 280 000 barrels a day (bbl/day) or 94% of the scenario-projected 1990 shale oil production, include

- Union,
- Paraho, at Anvil Points,
- Superior,
- Mobil and Chevron, in South Piceance Basin,
- C-a,
- C-b,
- U-a, U-b, and
- TOSCO, at Sand Wash, Utah.

The DOE scenario for these facilities is shown in Table VI. The locations of the Colorado facilities are shown in Fig. 2.

The scenario was created as a basis for analysis in the oil shale assessment, of which this study is a part. It was based upon information about the likely oil shale industry during the first half of 1980. While the plans of industrial firms and the government have already changed and are changing constantly, the scenario is taken as a reasonable basis for analyzing the regional and national impacts of developing an oil shale industry. It should not be construed to be a prediction of the exact configuration of the industry.

Construction and operation work force estimates, supplied by the Technology Characterization task of this DOE Oil Shale Technology Assessment, are shown in Table VII. Development of the work force projections required an evaluation of possible shale oil production levels for each company, characterization of each extraction technology, and estimates of facility expansion plans beyond the time period of this assessment.

TABLE VI

DOE SCENARIO OF OIL SHALE PRODUCTION (bbl/day)

Tract (Company)	Process	1982	1983	1984	1985	1986	1987	1988	1989	1990
Long Ridge	Union B/SGR	8 000	8 800	8 800	17 600	19 400	19 400	30 000	30 000	30 000
	TOSCO II (Est)		880	1 760	1 760	1 940	1 940	3 000	3 000	3 000
Anvil Points	Paraho Direct (Est)		8 000	8 000	8 800	8 800	9 700	9 700	10 700	10 700
	Lurgi-Ruhrgas (Est)			800	880	880	970	970	1 070	1 070
Superior	Circular Grate				12 000	12 000	13 200	13 200	20 000	20 000
	Lurgi-Ruhrgas (Est)					1 200	1 320	1 320	2 000	2 000
Sand Wash, Utah	TOSCO II						10 000	10 000	11 000	11 000
DOW (Colony)	TOSCO II				27 500	41 250	50 000	55 000	55 000	55 000
Tract U-a, U-b	Paraho Indirect						10 000	10 000	11 000	11 000
	Lurgi-Ruhrgas (Est)							1 000	1 100	1 100
So. Piceance Basin (Chevron)	Unknown A							10 000	10 000	10 000
So. Piceance Basin (Mobil)	Unknown B								10 000	10 000
Tract C-a	C-a MIS						37 500	47 250	57 000	57 000
	Lurgi or TOSCO II (Est)						12 500	15 750	19 000	19 000
Tract C-b	C-b MIS		10 000	20 000	30 000	50 000	50 000	50 000	50 000	50 000

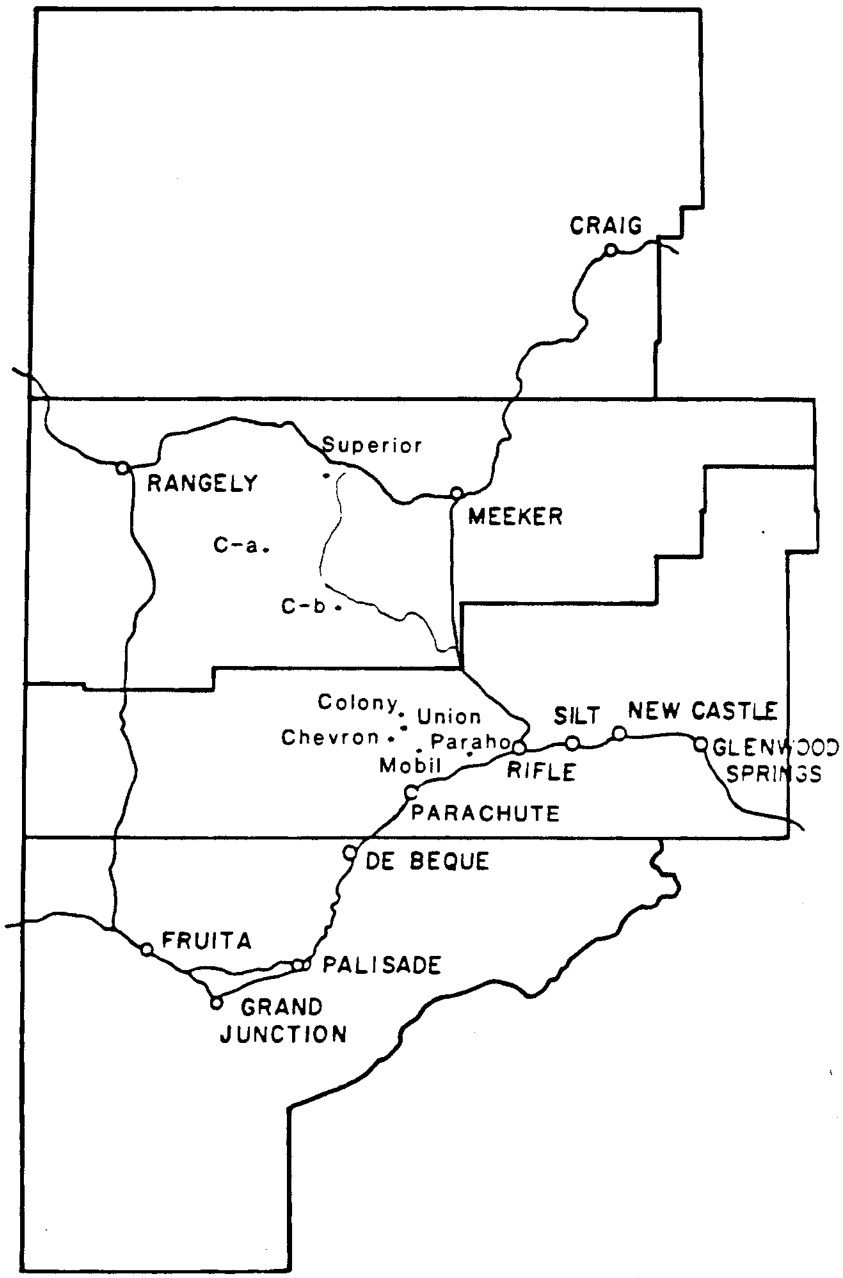

Fig. 2. Site of Colorado oil shale facilities in scenario.

Development of a work force scenario is handicapped because no large-scale oil shale facility has ever been built in this country; therefore, work force requirements represent best-guess estimates. Also, it may be extremely difficult to recruit the enormous levels of manpower required to achieve projected levels of production. Any number of other factors, for example adverse socioeconomic impacts, could affect the number of employees needed to reach proposed levels of production. Unfortunately, population projections cannot be more accurate than the employment projections on which they are based.[2,13]

TABLE VII

DOE SCENARIO OF OIL SHALE WORK FORCE

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Colorado											
Garfield County:											
Union (Construction)	300	800	700	700	800	700	200	0	0	0	0
(Operations)	100	250	400	400	400	400	550	700	700	700	700
Anvil Points (Construction	0	300	500	200	250	400	200	100	0	0	0
(Operations)	80	200	300	300	300	300	300	450	450	550	550
Colony (Construction)	400	600	1 000	1 500	2 000	2 000	2 000	2 000	2 000	1 500	1 000
(Operations)	150	300	500	800	800	800	800	1 200	1 500	1 800	2 000
Chevron/Mobil (Construction)	0	0	0	0	100	300	500	500	600	600	200
(Operations)	0	0	0	0	100	100	200	300	300	500	500
Rio Blanco County:											
Superior (Construction)	0	0	150	275	450	800	710	100	400	600	100
(Operations)	20	50	110	185	405	540	600	920	920	1 200	1 200
C-a (Construction)	0	0	0	100	300	300	500	1 000	1 500	800	500
(Operations)	0	250	350	300	300	300	300	600	1 000	1 200	1 500
C-b (Construction)	0	0	0	100	300	300	500	1 000	1 500	800	500
(Operations)	0	250	350	300	300	300	300	600	1 000	1 200	1 500
Utah											
Uintah County:											
Sand Wash (Construction)	0	0	0	100	300	500	500	500	100	100	100
(Operations)	0	0	0	100	100	200	300	200	300	350	350
U-a, U-b (Construction)	0	0	0	100	300	500	500	200	100	0	0
(Operations)	0	0	0	100	200	300	300	300	400	400	400
TOTAL	1 050	3 000	4 360	5 560	7 705	9 040	9 160	10 770	12 770	12 300	11 100

Regardless of the accuracy of work force estimates, there are several features of the DOE scenario that should be discussed. These features include (1) timing of the different oil shale developments, (2) changes in size of project work forces, and (3) size of the permanent work force.

As specified by the scenario, construction of three of the five oil shale facilities in the Parachute Creek basin will begin early in the 1980s. Construction work forces will peak mid-decade, and as Union and Paraho phase out construction workers, Chevron and Mobil will peak. The combination of these five facilities effectively requires the presence of a very large construction work force through the decade, (Fig. 3). The C-a, C-b, and Superior facilities together require similar levels of construction workers, although the peak construction years occur later in the decade, as shown in Fig. 4. Figures 3 and 4 reveal that both the total numbers and the yearly increments are quite large. Individual facilities show similarly large annual increments.

Colony, C-a, and C-b expand and reduce construction work forces by as many as 500 workers in any one year. In addition, the profiles of the construction work force for Anvil Points and Superior are uneven. The drop in the work forces occurring between the construction phases of these facilities could imply changes in worker residences, aggravating problems the region already will experience in accommodating the large influx of temporary workers. Furthermore, the construction work force numbers employed in this study conceal changing requirements for different skills and thus could understate the effective changes and turnover of the work force. Industry's adoption of policies designed to create a stable, indigenous construction work force, however, could substantially reduce turnover.

The permanent work force requirements show a more even pattern of growth, although the increment of growth in any one year is large--as many as 400 workers at one facility. The total operation work force for the Colorado oil shale facilities is shown in Fig. 5.

The total work force requirements (Fig. 6) represent a very large influx of employees into a region in which the current total labor force is estimated at less than 60 000.[14] In the counties of Rio Blanco and Garfield, where most of the facilities will be located, the current total work force is 14 756, and the current unemployment rate is very low (Table II).

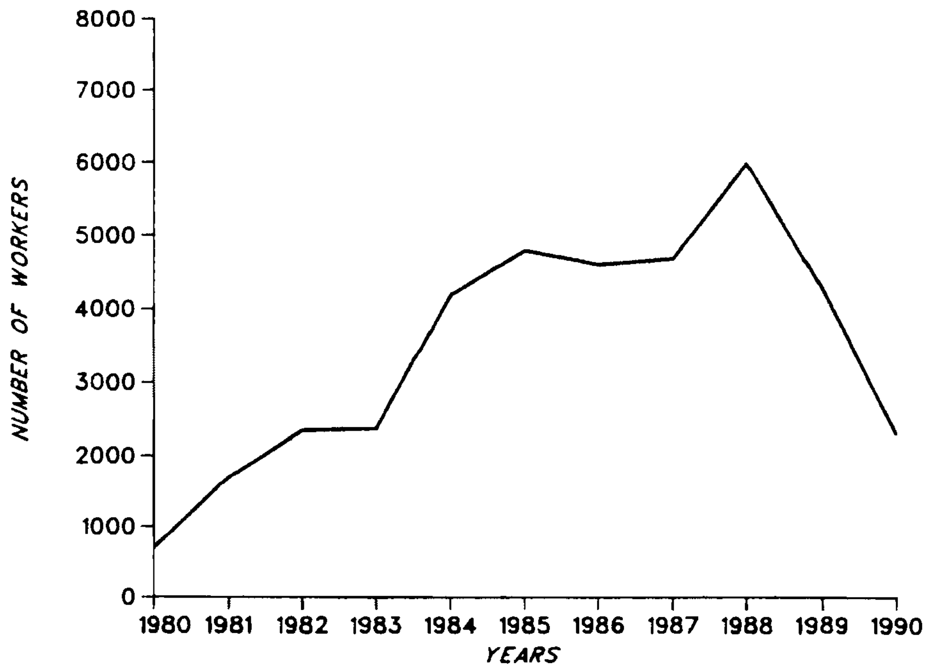

Fig. 3. Projected construction work force at the Parachute Creek facilities.

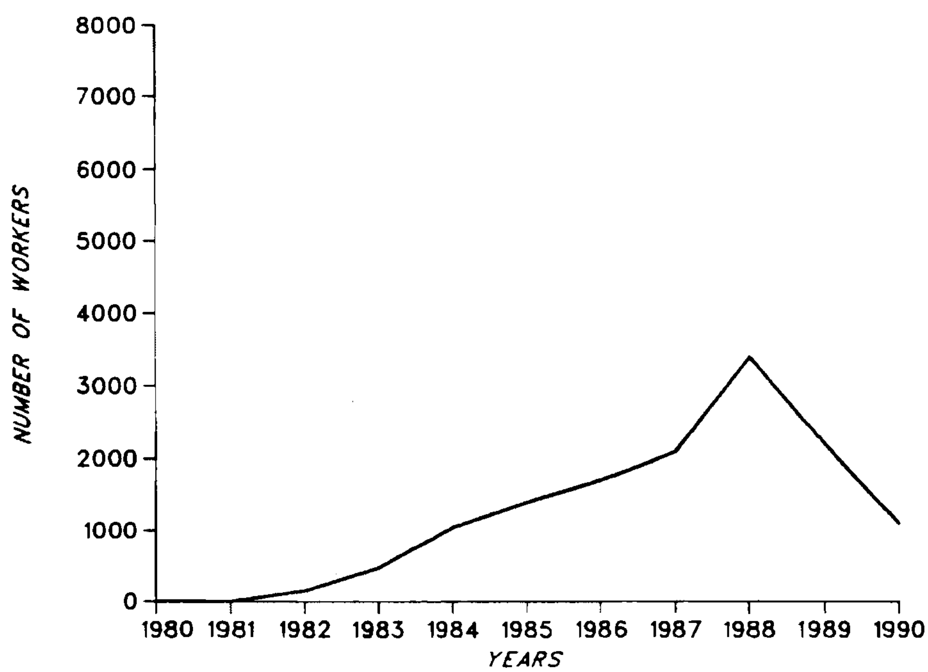

Fig. 4. Projected construction work force at C-a, C-b, and Superior sites.

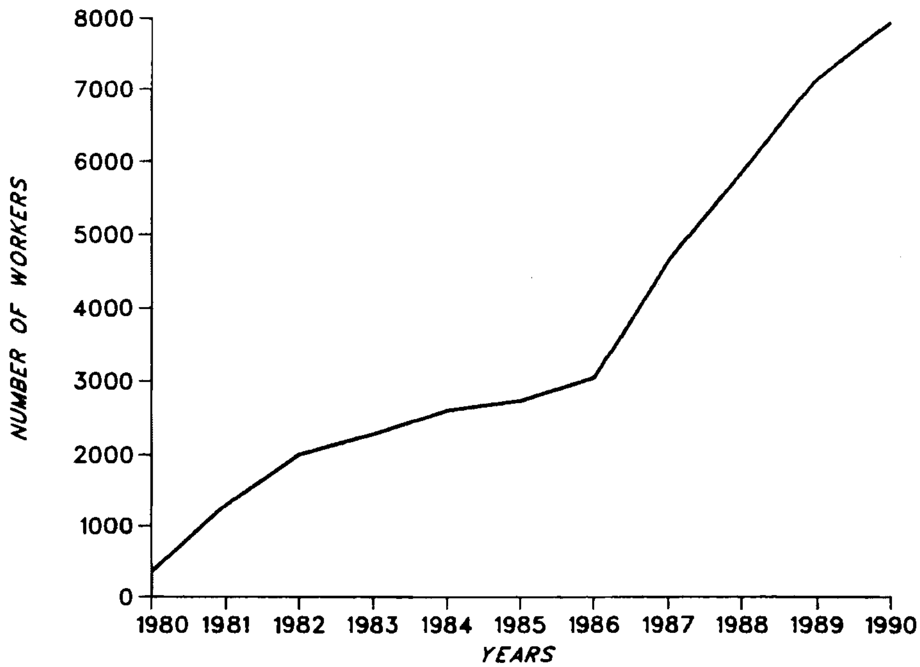

Fig. 5. Projected operation work force for the Colorado facilities.

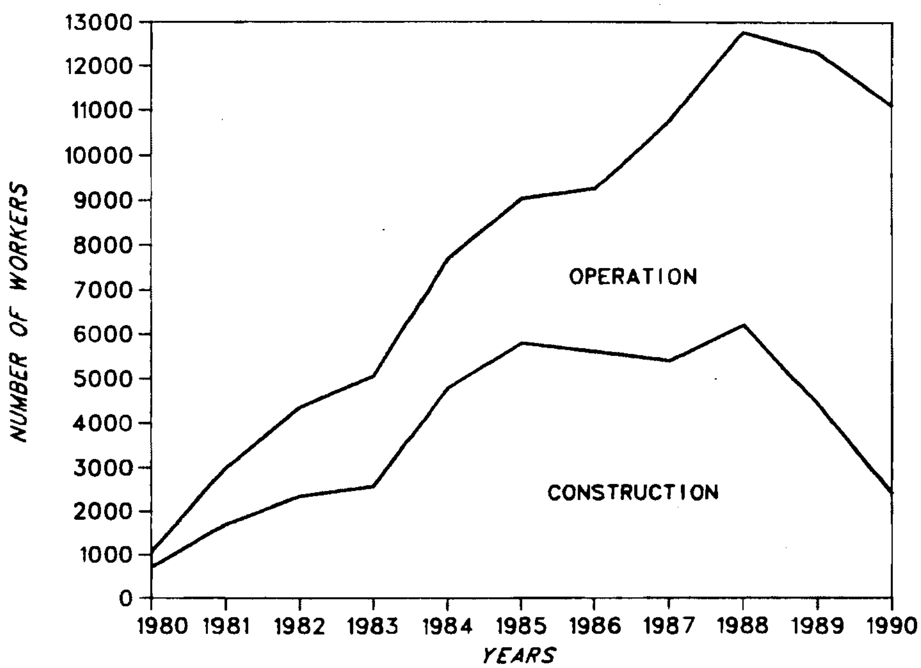

Fig. 6. Projected construction and operation work forces.

These work force requirements reveal an important characteristic that distinguishes oil shale development from certain other energy facilities. While the oil shale construction work force is large, the growth and continuing presence of a substantial operation work force moderates the employment decline after the peak year. This characteristic can be seen in the total work force estimates of most of the individual facilities in the scenario. We believe that the same trend would be seen on a regional level if projections were extended beyond 1990.

IV. POPULATION IMPACTS

A. Introduction

Population impacts of the anticipated energy development in northwest Colorado have been estimated by a great number of reserch organizations and government agencies. Although many different methods of estimating total population growth have been employed, probably the greatest source of disagreement between the estimates is the difference in assumptions regarding the levels and types of energy development that will occur.

In its 1980 report to the Colorado Legislature, the Colorado Department of Local Affairs described the prospects for energy-related growth in Colorado.[15] Coal production presently amounts to 18 million tons per year, and could increase to as much as 58 million tons per year by 1990. The state could expect production of shale oil in 1990 to reach 360 000 bbl/day.

The State's Division of Energy and Minerals has estimated the population impact according to low, medium, and high scenarios of energy development.[16] By 1990, the population impacts caused by coal development in Mesa, Moffat, Rio Blanco, and Garfield Counties are estimated to exceed 3100 persons. Peak construction years for power plants could increase population by 10 000. Oil shale development is estimated to cause population increases in excess of 54 800 people. The 1990 regional population induced by the high scenario of energy development is estimated to be greater than 95 000 persons. The Division of Energy and Minerals projected 1990 total population for all four counties, including normal population growth, would exceed 227 000 persons.

A similar projection of population growth was reported by the Colorado Department of Natural Resources.[17] Given high levels of energy production, the report projected a total population of 242 600 in the four-county region by 1990.

The Colorado West Area Council of Governments (COG) also developed population growth estimates based on three scenarios of energy development.[18] Although the levels of production are not specified in the COG report, the company employment projections are incorporated into a mid-scenario, Scenario II, (Table VIII). Regional population totals projected by the COG under Scenario II are 290 076 by 1990.

The impacts of population growth induced by the development of an oil shale industry, therefore, must be viewed in the context of total energy development in the region. The population projections in the analysis below account only for the impacts induced by DOE's oil shale scenario and, consequently, reflect only one possible scenario of development. Population projections in this analysis would be underestimated if any other energy development in the region were to occur simultaneously.

Moreover, in view of the simultaneous development of several major energy resources in the region, observed socioeconomic effects are difficult to attribute to the development of any single energy resource. Because of the low unemployment rates (3.7-6.9%)[14] of the four northwest counties of

TABLE VIII

TOTAL EMPLOYMENT BY PROJECT,
COLORADO WEST AREA COUNCIL OF GOVERNMENTS SCENARIO II

PROJECT	1980	1981	1982	1983	1984	1985	1990	1995	2000
C-a	220	220	220	750	1800	2100	1500	1500	1500
C-b	250	800	1600	2950	2900	2800	2300	2300	2300
Paraho	175	175	175	175	175	175	175	175	175
Anshutz	260	300	350	350	350	350	350	350	350
Mid Cont.	0	0	0	0	0	0	0	0	0
Superior	50	266	458	847	1320	1310	920	920	920
Colo-Wyo.	440	483	485	485	485	485	485	485	485
Utah Inter.	275	330	330	435	480	480	680	680	680
Colo. Ute	350	350	570	310	235	235	235	235	235
Empire	300	300	300	350	350	350	350	350	350
GEX/CMC	221	241	289	297	325	335	400	400	400
Other Coal	200	200	300	300	300	350	350	350	350
Sheridan	177	202	287	342	397	475	475	475	475
Energy Fuels	60	60	90	115	140	165	165	165	165
Union	150	581	626	238	238	238	600	1600	1600
Colony	0	200	1000	2540	1570	1040	1040	1040	1040
Storm King	150	150	150	150	150	150	300	300	300
Northern Min.	160	362	401	401	401	401	401	401	401
Cont. Mesa II	0	0	72	140	160	207	207	207	207

SOURCE: Colorado West Area Council of Governments

Colorado, nonlocal employees will account for almost 100% of the energy-induced employment. Population pressures experienced in any one town or county may result from more than one type of energy facility. Therefore, the need for new or expanded public facilities and services may not necessarily be attributable to any one type of facility. In this analysis, impacts will be analyzed in terms of total employment in the area and total influx of new population.

B. Geographic Distribution

Given the work force projections discussed in Sec. III, the settlement patterns of nonlocal employees must be estimated. There are many factors that influence these patterns, not all of which can be readily quantified. Furthermore, these factors vary in relative importance with respect to the values and expectations of the analyst and the individual employees.

Among the most important factors are the size of the community and the distance of that community from the site of employment. These factors have been employed in gravity models to predict the geographic distribution of nonlocal employees. In general, the gravity model assumes that the population capture rate of a community is directly proportional to its size and inversely proportional to its distance from the site of employment. A simple gravity model has the form

$$G_i = \frac{P_i}{D_i^a} \quad ,$$

where G_i is the gravity index, P_i is the current population of community i, D_i is a measure of the distance to the site of employment from community i, and a is a weighting coefficient, usually $1 < a < 2$. G_i can be normalized against the indices of other towns in a region to provide the percentage of total population expected to settle in a particular community.

Studies that have employed the gravity model for geographic distribution of population have variously modified the model's formula to account for particular town or commuting characteristics. The size of the community (P_i) implies a measure of availability of medical, professional, and retail services; employment opportunities for other family members; availability of housing; educational facilities; and utilities. Gravity models have incorporated "attractiveness coefficients" or other variables to account for such factors as available housing stock, housing costs, size of school districts, and work-related trips.[2] Changes in the coefficient of the measure of distance between worksite and townsite account for commuting preferences. However, other factors are important, particularly in the northwest Colorado study region. Although commuting distances from one employment site to different communities may be nearly equidistant, commuting times may differ greatly. Commuting times vary with the quality of the roads, usually two lanes wide, and with the season. High terrain features of the region force some roads over mountain passes, thereby greatly increasing travel time during winter months.

Even with elaborate modifications, gravity models may not provide accurate predictions of population distribution, particularly in a region that will be subject to continual growth pressures over many years from many different developments. A measure of the current community attractiveness may not represent the attractiveness of that community in five years. Speculation may drive the cost of land and new housing beyond the financial limits of the prospective buyer. Early growth pressures in a community may reduce its attractiveness to newcomers if, for example, expansion of public facilities and provision of adequate public services have not kept pace with population changes. Furthermore, the development or lack of growth management policies may create patterns of growth that either preserve or, to various degrees, alter the character of the existing community. Finally, settlement patterns now may be influenced by the proximity of existing regional trade centers. Today settlement patterns are dominated by the location of the major east-west interstate highway, I-70, that crosses the study region in the south. Much of this highway has been expanded to four lanes and affords ready access to Grand Junction, the largest city in the region, and to its many facilities and services. However, as smaller cities in the region such as Rifle or Craig expand public facilities and services to accommodate new population, they may be able to provide some of the services that make Grand Junction so attractive today. People, therefore, may be more willing to live farther away from this major city.

Assessments of the population impacts of oil shale development have used gravity models, distribution scenarios, and simple weighting techniques to estimate geographic distribution. In the Meeker case study, Denver Research Institute (DRI)[19] based the geographic allocation of population on the analyst's subjective evaluation of community attractiveness, access to regional trade centers, commuting distances, community attitudes toward growth, and other factors. The distribution from oil shale facilities is presented in Table IX.

The socioeconomic impact assessment prepared for the C-b tract oil shale development[20] employed four scenarios of distribution, although only one scenario was employed to assess demand and cost impacts for housing and public facilities and services. The alternatives represented by these scenarios were scattered development, all of the population going to Meeker and Rifle according to three different distributions, and the development of a new town.

The socioeconomic impact assessment of the Rio Blanco Oil Shale Project[21] did not explain the derivation of the population allocation percentages. However, the report did underscore the need to construct a road from the C-a tract to Rangely (Fig. 2) by indicating two distribution patterns, shown below.

	Rangely	Meeker	Rifle	Glenwood Springs
With road	77%	9%	6%	8%
Without road	13%	39%	24%	24%

The COG employs a set of population growth estimates developed for planning purposes.[18] A gravity model is used to determine settlement patterns of new population. Table X presents the oil shale related figures. These figures

TABLE IX

TEMPORARY AND PERMANENT NEW BASIC EMPLOYMENT POPULATION DISTRIBUTION[a] (%)

	County			
	Rio Blanco	Mesa	Garfield	Moffat
Paraho	0	0	100	0
Superior	100	0	0	0
C-b	50	0	50	0
U-a, U-b	70[b]	0	0	0
C-a	100	0	0	0

[a]Ref. 19.

[b]Assumed road to Rangely, Colorado.

TABLE X

EMPLOYMENT DISTRIBUTION
(COLORADO WEST AREA COUNCIL OF GOVERNMENTS)

Project	Carbondale	Glenwood Springs	Parachute	New Castle	Rifle	Silt	Collbran	DeBeque	Fruita	Grand Junction	Palisade	Craig	Dinosaur	Meeker	Rangely	Battlement Mesa	Garfield BOC	Mesa BOC	Moffat BOC	Rio Blanco BOC
C-a	0	1	0	0	34	3	0	0	0	2	0.5	0	1	22	28	0	4	0.5	0	4
C-b	0	2	2	1	47	2	0	0	0.5	1.5	0.5	0	0	30	2	5	3	0.5	0	3
Paraho	0	3	12	3	64	9	0	0	0	0	0	0	0	0	0	0	9	0	0	0
Superior	0	2	0	0	16	2	0	0	1	9	1	0	0	46	11	0	5	3	0	4
Union	0	10	15	0	18	2	0	5	0	17	2	0	0	0	0	25	3	3	0	0
Colony	0	0	10	0	5	0	0	5	0	0	0	0	0	0	0	80	0	0	0	0

[a]Numbers indicate percent of total employment per project.

are updated and revised periodically, taking into consideration changes in housing stock and reported settlement patterns of oil shale company employees. Table XI contains the settlement patterns of the C-b tract employees recently reported by Cathedral Bluffs, Shale Oil Project.

Table XII presents the distribution pattern developed for this study. The numbers are based on considerations of growth pressures implied by the specific construction and operation schedules of the ten oil shale facilities in the DOE scenario. These facilities are grouped by regions, and thus residential patterns of workers from facilities in the same region are identical. Distribution numbers in each region are allowed to change with population pressures exerted by oil shale development in other regions. In addition, emphasis is placed on the influence of municipal growth management policies on settlement patterns. The distribution pattern takes into account housing availability, costs of housing, excess capacity in public infrastructure, and access to major transportation corridors and regional trade centers.

As shown in Table XII, the population distribution patterns assume that development will occur in and around the existing communities of Rifle, Meeker, Rangely, Grand Junction, Glenwood Springs, and Craig. The development of the planned town of Battlement Mesa also is assumed to proceed. Small communities, however, are expected to be affected by the population influx, although the

TABLE XI

REPORTED PLACE OF RESIDENCE OF C-b EMPLOYEES

	Percentage of Workers Surveyed Residing There January 1980 (N=409)
Rifle	61
Meeker	14
Silt	6
Grand Junction	7
Glenwood Springs	2
New Castle	2
Parachute	2
Rangely	0
Other West Slope	1
Piceance Creek	0
Other Colorado	1
Outside Colorado	1
Unknown	3
TOTAL	100

SOURCE: "Cathedral Bluffs Shale Oil Project Socioeconomic Monitoring Report," No. 9, Quality Development Associates, Inc., Denver Colorado, (1980).

TABLE XII

EMPLOYMENT POPULATION DISTRIBUTION
(LOS ALAMOS METHOD)

	Battlement Mesa	Rifle	Meeker	Rangely	Grand Junction	Glenwood Springs	Craig	Other
	% Workers to Towns Per Year From Union, DOW, Anvil Points, Chevron, and Mobil							
1980	0	40	0	0	15	5	0	40
1981	15	30	0	0	15	5	0	35
1982	30	30	0	0	15	5	0	15
1983	45	30	0	0	10	5	0	10
1984	55	25	0	0	10	5	0	5
1985	55	25	0	0	10	5	0	5
1986	55	25	0	0	10	5	0	5
1987	60	20	0	0	10	5	0	5
1988	60	20	0	0	10	5	0	5
1989	60	20	0	0	10	5	0	5
1990	60	20	0	0	10	5	0	5
	% Workers to Towns Per Year From Superior							
1980	0	15	40	20	0	0	20	5
1981	0	15	40	20	0	0	20	5
1982	0	15	40	20	0	0	20	5
1983	0	15	40	20	0	0	20	5
1984	0	15	40	20	0	0	20	5
1985	0	15	40	20	0	0	20	5
1986	0	15	40	20	0	0	20	5
1987	0	15	40	20	0	0	20	5
1988	0	15	40	20	0	0	20	5
1989	0	15	40	20	0	0	20	5
1990	0	15	40	20	0	0	20	5
	% Workers to Towns Per Year From C-a and C-b							
1980	0	35	40	15	0	5	0	5
1981	0	35	40	15	0	5	0	5
1982	0	35	40	15	0	5	0	5
1983	0	35	40	15	0	5	0	5
1984	0	35	40	15	0	5	0	5
1985	0	35	40	15	0	5	0	5
1986	0	35	40	15	0	5	0	5
1987	0	30	40	15	0	5	5	5
1988	0	30	40	15	0	5	5	5
1989	0	30	40	15	0	5	5	5
1990	0	30	40	15	0	5	5	5
	% Workers to Towns Per Year From Utah Sites							
1980	0	0	0	30	0	0	0	5
1981	0	0	0	30	0	0	0	5
1982	0	0	0	30	0	0	0	5
1983	0	0	0	30	0	0	0	5
1984	0	0	0	30	0	0	0	5
1985	0	0	0	30	0	0	0	5
1986	0	0	0	30	0	0	0	5
1987	0	0	0	30	0	0	0	5
1988	0	0	0	30	0	0	0	5
1989	0	0	0	30	0	0	0	5
1990	0	0	0	30	0	0	0	5

capture rate is estimated to be very small. Mobile home parks and a few dwellings will be available for nonlocal construction and operating workers. The category of "other" includes the possible settlement of nonlocal employees in the small communities and rural areas of the region. An increasing share of the incoming population in the south probably will be received by Battlement Mesa. In several years, when parks, shopping areas, permanent homes, schools (K-12), and other community services have been established, Battlement Mesa may attract greater numbers of employees who might otherwise have settled in Rifle, Grand Junction, or in the little towns along I-70.

The Los Alamos distribution pattern assumes no uncontrolled growth. There are several reasons for this assumption. Many municipalities in the study region have strongly encouraged new development in areas within the town rather than on the periphery or beyond municipal boundaries.

Rio Blanco County, in particular, has adopted a very strong position against uncontrolled, or "laissez-faire," growth. Services such as fire and police protection, educational facilities, and utilities are more difficult and much more expensive to provide to scattered sites of development than to higher density communities. The need for these immediate services incudes the proliferation of special districts that exacerbate planning and management problems of municipal officials. In addition, scattered development is associated with increased traffic and fuel use, consumption of agricultural land, increased air pollution, lack of community identity, and disregard for existing community goals.

Concentrated growth in and around existing communities allows more efficient and less costly provision of public services and expansion of public infrastructure.[23] Public transportation services can reduce private vehicle use, and children need not be bused long distances to school. Agricultural lands are more easily preserved.[24]

Concentrated growth in and around existing communities, however, requires a concerted planning, coordination, and growth management effort on the part of local officials, including careful land use planning and development of comprehensive fiscal policies. Lack of experience can handicap these efforts. Furthermore, these activities must be undertaken in a public arena where land use planning is anathema to many, where the approach to problem solving is informal and ad hoc, and where individual freedom of action and economic pursuit are paramount. Consequently, population growth may well occur outside of towns, scattered in developments along major transportation corridors.[24] Sprawl growth, such as described above, was incorporated into the high scenario population distribution of the COG projections.[18]

The forecasted settlement patterns of the workers associated with the DOE scenario are shown in Table XIII. According to these estimates, rapid and steady growth will occur in Battlement Mesa, Rifle, and Meeker. Rangely will experience substantial growth, although less spectacular than the growth in Rifle or Meeker. Small towns and rural areas will experience a comparatively small net growth.

In addition, Rifle and Meeker reflect the changes in the oil shale production scenario. An enormous worker influx will occur in 1988, the impacts of which could be alleviated through the provision of bachelor quarters. Attractive, though temporary, housing for the nonlocal workers has been provided by industry to secure employee satisfaction and work force stability. Nonlocal married workers leave their families at home and, in effect, become weekend commuters. Such a solution may be preferable to searching for adequate housing for the entire family, and the business community may welcome the advantages of added revenues without the full cost of providing for families.

For comparison to the Los Alamos distribution, Table XIV contains the results of a distribution of the oil shale work force scenario based on the COG method discussed earlier (Table X). Patterns similar to those described above are observed in Battlement Mesa, Rifle, Meeker, and Rangely. The major difference between the COG and Los Alamos distributions derives from the COG assumption of large growth in small towns and rural areas of the region. This assumption forces large numbers of workers into small communities such as DeBeque, Parachute, Silt, and New Castle, and minimizes the attraction of more

TABLE XIII

GEOGRAPHIC DISTRIBUTION OF WORK FORCE
(LOS ALAMOS METHOD)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Battlement Mesa	0	367	1190	1759	2612	2750	2612	3150	3330	3390	2970
Rifle	415	917	1303	1518	1726	1871	1943	2163	2808	2600	2385
Meeker	8	220	384	504	822	1016	1164	1688	2528	2320	2120
Rangely	4	85	157	332	621	898	952	1074	1284	1215	1115
Grand Junction	155	367	510	390	475	500	475	525	555	265	495
Glenwood Springs	51	147	205	235	297	310	317	422	527	482	447
Craig	4	10	52	92	171	260	262	364	514	560	460
Other	417	887	559	470	385	460	460	439	639	615	555
To Utah	0	0	0	260	585	975	975	845	585	553	553

TABLE XIV

GEOGRAPHIC DISTRIBUTION OF WORK FORCE
(COLORADO WEST AREA COUNCIL OF GOVERNMENTS METHOD)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Battlement Mesa	540	995	1492	2135	2620	2645	2642	3015	3325	3190	2850
Rifle	153	764	1110	1030	1366	1558	1578	2241	2987	2749	2582
Meeker	9	153	301	419	705	928	1018	1301	1907	1868	1638
Rangley	2	83	136	300	566	809	868	1007	1207	1084	1131
Grand Junction	69	191	222	232	335	396	392	402	477	538	420
Glenwood Springs	42	128	149	145	191	215	210	234	274	292	240
Craig	0	0	0	0	0	0	0	0	0	0	0
Other	235	686	950	1039	1367	1514	1477	1625	2008	2026	1686
To Utah	0	0	0	260	585	975	975	845	585	553	553

distant but larger communities such as Glenwood Springs, Grand Junction, and Craig. Table XV presents the distances between the planned and existing communities and the oil shale facilities in the scenario.

C. Indirect Employment

The total employment impacts implied by the work force requirements of the oil shale production scenario require an estimate of induced indirect employment. Although input/output analysis has been used to estimate indirect employment stimulated by energy development,[2,25] the data requirements for construction of the input/output tables require substantial work and expense, are region-specific, and consequently discourage the widespread use of input/output analysis for socioeconomic assessments. More popular is the use of employment multipliers.

TABLE XV

DISTANCES BETWEEN COLORADO OIL SHALE SITES AND
EXISTING COMMUNITIES

	C-a	C-b	Chevron Mobil	Colony	Paraho	Superior	Union
Battlement Mesa	81	57	10	12	10	79	12
Meeker	55	44	67	69	51	22	69
Rifle	65	41	26	28	10	63	28
Rangely	70	62	122	124	106	37	124
Grand Junction	123	99	52	54	48	121	54
Glenwood Springs	88	64	49	51	33	89	51
Craig	106	95	118	120	102	73	120

The export and local sectors of the economy are identified on the basis of the source of demand. Agriculture, forestry, mining, Federal Government, and any manufacturing, wholesale employment, and energy production in excess of that which is consumed locally are basic employment and are treated as components of the export sector of the economy. All other employment, such as retail, health, education, local government, and professional, is considered to be nonbasic, or service, employment. Several types of multipliers have been employed to relate nonbasic to basic employment,[2,6] and examples of those used in previous assessments are presented in Table XVI.

Although adjustments in employment multipliers have attempted to account for the dynamic changes in the relationship between the basic and nonbasic sectors of the economy as a result of large-scale and rapid energy development in rural areas, there is little agreement on the best technique.[12] The reliability of the results has been questioned.[6] A DRI report concluded from its sensitivity analysis of employment impact in Rio Blanco County that total employment projections are far more dependent on the energy scenario and settlement patterns than on the manipulation of indirect employment calculations.[19]

For purposes of this assessment, indirect employment was calculated by two methods, both using employment multipliers. The first method is based on the DRI demonstration methodology for the Rio Blanco County analysis.[19] The multipliers are shown in Table XVII. The second method employed multipliers used in COG's population projections, as shown in Table XVIII.

TABLE XVI

REPORTED NONBASIC/BASIC EMPLOYMENT MULTIPLIERS

Rio Blanco Oil Shale Project (1976)	0.5
C-b Socioeconomic Assessment (1976)	0.5-1.5
Uintah Basin Socioeconomic Impact Assessment (1975)	0.3-1.5
Denver Research Institute (1979)	0.6 construction 1.2 operation
Booz, Allen and Hamilton, Inc. (1974)	0.45-2.00
Colony Development Operation (1974)	0.5-1.0
Gilmore and Duff (1975)	0.8-2.2
THK Associates (1974)	2.0

SOURCES: D. A. Rapp, "Uranium Mining and Milling Work Force Characteristics in the Western US," Los Alamos National Laboratory report LA-8656-MS (December 1980).

"Socio-Economic Impact Study of Oil Shale Development in the Uintah Basin," prepared by Western Environmental Associates, Inc., for the White River Shale Project (November 1975).

The results are shown in Table XIX. The initial distribution of basic employees used the settlement pattern contained in Table XII.

Comparison of the results of these two methods for Battlement Mesa, Meeker, and Grand Junction reveals some differences in projected indirect employment impacts. In general, the multipliers in the COG matrix are higher than the effective Los Alamos multipliers. The multipliers for Grand Junction, however, are similar. Thus, indirect employment impacts predicted by the COG method for Meeker and Battlement Mesa are larger than those estimated by the other method, and the impacts predicted for Grand Junction are similar.

Both methods may underestimate the indirect, or secondary, impacts of oil shale development in Grand Junction. Local officials are extremely concerned that this city will experience large, and possibly rapid, population growth associated with new and expanded support and service industries.

TABLE XVII

LOS ALAMOS EMPLOYMENT MULTIPLIERS

Construction Work Force

- All towns have a 2-year lagging multiplier of 0.5 (0.25/year) applied to 50% of the construction work force per year
- Period of application varies for each town
- Towns also have a 3-year lagging multiplier that varies both in period of application and magnitude--applied to remaining 50% of the construction work force per year

Town	Last Year for Two Years	Last Year for Three Years	Three-Year Multiplier
Battlement Mesa	1986	1987	0.5
Rifle	1988	1987	0.5
Meeker	1988	1987	0.5
Rangely	1985	1985	0.5
Grand Junction	1988	1987	1.7
Glenwood Springs	1988	1987	0.5
Craig	1988	1987	0.5
Other	N/A	1987	0.4

Operations Work Force

- Magnitude varies with town--no lag assumed

Town	Multiplier
Battlement Mesa	1.2
Rifle	1.2
Meeker	1.2
Rangley	1.2
Grand Junction	1.7
Glenwood Springs	1.2
Craig	1.2
Other	0.4

TABLE XVIII

COLORADO WEST AREA COUNCIL OF GOVERNMENTS EMPLOYMENT MULTIPLIERS

Town	1980	1981	1982	1983	1984	1985	1990	1995	2000
Carbondale	1.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Glenwood Springs	1.1	1.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Parachute	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
New Castle	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Rifle	1.1	1.1	1.1	1.1	1.1	1.4	1.4	1.4	1.4
Silt	0.4	0.4	0.6	0.6	0.8	0.8	0.8	0.8	0.8
DeBeque	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Fruita	0.4	0.4	0.6	0.6	0.8	0.8	0.8	0.8	0.8
Grand Junction	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.7	1.7
Palisade	0.4	0.4	0.6	0.6	0.8	0.8	0.8	0.8	0.8
Craig	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Battlement Mesa	0.4	0.4	0.4	0.8	1.0	1.4	1.8	1.8	1.8
Dinosaur	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Meeker	0.4	0.6	0.8	0.8	0.8	1.2	1.2	1.2	1.2
Rangely	0.4	0.4	0.6	0.6	0.8	1.2	1.2	1.2	1.2
Garfield BOC	1.1	1.1	1.1	1.1	1.1	1.4	1.4	1.4	1.4
Mesa BOC	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.7	1.7
Moffat BOC	1.1	1.1	1.1	1.1	1.1	1.4	1.4	1.4	1.4
Rio Blanco BOC	0.8	0.8	0.8	0.8	1.2	1.2	1.2	1.2	1.2

TABLE XIX

GEOGRAPHIC DISTRIBUTION OF NONBASIC WORK FORCE
COMPARISON OF LOS ALAMOS AND COLORADO WEST AREA COUNCIL OF GOVERNMENTS METHODS

Los Alamos Method	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Battlement Mesa	0	241	931	1623	2356	2737	2953	2869	3684	3816	3420
Meeker	9	264	413	480	746	987	1164	1745	2431	2094	2456
Grand Junction	157	443	775	798	847	866	933	1027	1029	1142	757
COG Method											
Battlement Mesa	0	147	476	1404	2612	3850	3657	4410	4662	4746	5346
Meeker	3	132	307	403	657	1219	1396	2025	3033	2784	2544
Grand Junction	231	550	765	585	807	850	807	892	943	960	841

D. Family and Household Multipliers

Total population impacts are based on basic and nonbasic employment projections. Much uncertainty lies in the number of family members who will accompany energy workers. A 1975 survey of construction workers in energy-impacted communities in the Rocky Mountain Region determined that the average family size of nonlocal workers was 3.78.[26] Monitoring data collected on C-b tract workers indicate that the average family size of all married workers is 3.1 persons, and the average influx of persons per nonlocal worker is 2.1.[22] The Colorado State Demographer's Office reports the 1979 current estimate of average household size in Garfield County as 2.79, and in Rio Blanco County as 2.95.[27] A study of nonlocal construction work forces in Mercer County, North Dakota, discovered a dramatically lower average household size of 1.7.[28] The COG studied recent trends and concluded that the average household size in the four-county region is 2.75.

Table XX presents some of the family multipliers employed by other assessments. In addition, Table XX presents the assumptions used in this analysis.

E. Total Population Impacts

The results of the population impact analysis are shown in Table XXI. The profiles of population growth induced by the DOE oil shale scenario can be seen in Figs. 7-13.

The pace of oil shale development early in the decade is reflected in the growth of Battlement Mesa, Grand Junction, and Rifle. Substantial population pressures arise by 1986, accelerating the rate of growth in Meeker, Rifle, and, to a lesser extent, in Craig and Glenwood Springs. Relatively steady growth is experienced in Rangely and Battlement Mesa. Most of the communities show a drop in population in 1990 that is a direct result of the decline in the oil shale construction work force implied by the scenario.

The scenario-induced population calculated by the Los Alamos method peaks at 40 649 new people in 1989, and levels off at 38 303 in 1990. The results of applying the COG distribution and indirect employment multipliers to the DOE work force scenario are shown in Table XXII. The total peak year population impact estimated by this procedure is somewhat greater--43 410, about 11% for the region.

TABLE XX

FAMILY-SIZE MULTIPLIERS

Los Alamos	Percent Single (or without family)	Percent Married	Family Size
Construction workers	50%	50%	2.1
Operation workers	20%	70%	3.1
(10% operation workers to be supplied by construction work force)			
Nonbasic	9%	40%	3.1
(51% to be supplied by other work force families)			
C-b[a]			
Construction	40%	60%	3.5
Operation	15%	85%	3.5
Nonbasic	9%	40%	3.5
Uintah Basin Assessment[b]			
Households per worker			0.90-0.68
Population per household (varied over 15-year period)			3.0 -3.2
DRI (Volume III)			
Construction	40%	60%	3.59
Other basic	10%	80%	3.55
Nonbasic	10%	60%	3.55
Rio Blanco Addendum[c]			
Basic employee	20%	80%	3.8
Nonbasic	9.6%	38.4%	3.8
COG			
Basic employee			2.0
Nonbasic employee			2.5

Div. of Energy and Minerals[d]	Population Multiplier
Construction	3.45
Operation	4.92

---

[a]"Oil Shale Tract C-b Socio-Economic Assessment: Volume II Impact Analysis," C-b Shale Oil Project (March 1976).

[b]"Socio-Economic Impact Study of Oil Shale Development in the Uintah Basin," Western Environmental Associates, Inc., for the White River Shale Project (November 1975).

[c]"Addendum to the Social and Economic Impact Statement of March 1976," Gulf Oil Corporation and Standard Oil Company (Indiana) (May 1977).

[d]"Energy Development Population Scenarios by County," State of Colorado, Department of Local Affairs, Division of Energy and Mineral Impact (November 23, 1979).

TABLE XXI

SCENARIO-INDUCED POPULATION
(LOS ALAMOS DISTRIBUTION METHOD)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Battlement Mesa	0	981	3 427	5 432	7 903	8 624	8 810	10 002	11 512	12 076	10 997
Rifle	1 123	2 749	4 073	4 738	5 233	5 642	6 005	6 987	8 892	9 047	8 856
Meeker	30	872	1 410	1 677	2 595	3 261	3 747	5 632	8 109	7 561	7 930
Rangely	14	337	565	1 061	1 878	2 767	3 056	3 803	4 450	4 395	4 204
Grand Junction	487	1 249	1 968	1 788	1 993	2 057	2 128	2 396	2 470	2 685	2 081
Glenwood Springs	105	333	486	563	684	720	758	1 024	1 276	1 434	1 295
Craig	10	29	114	206	404	614	637	967	1 266	1 624	1 333
Other	868	1 918	1 374	1 212	943	1 060	1 091	3 344	1 583	1 827	1 607
TOTAL	2 637	8 468	13 417	16 677	21 633	24 745	26 232	32 155	39 558	40 649	38 303

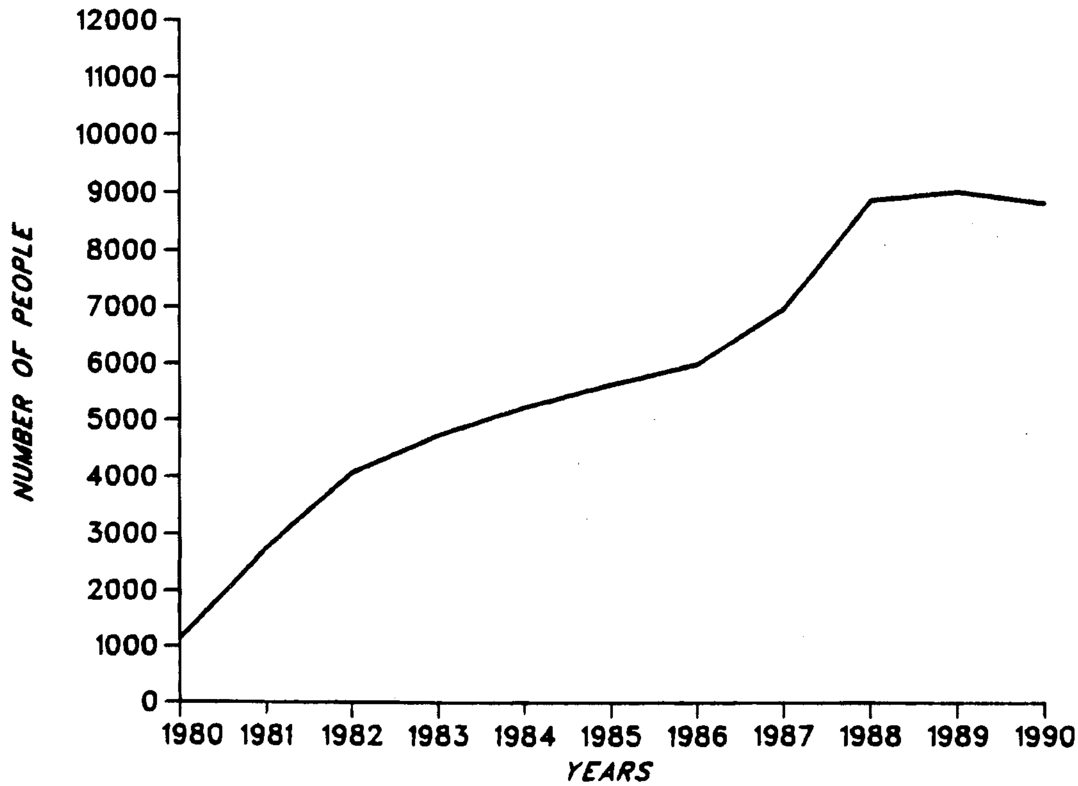

Fig. 7. Scenario-induced population growth: Rifle.

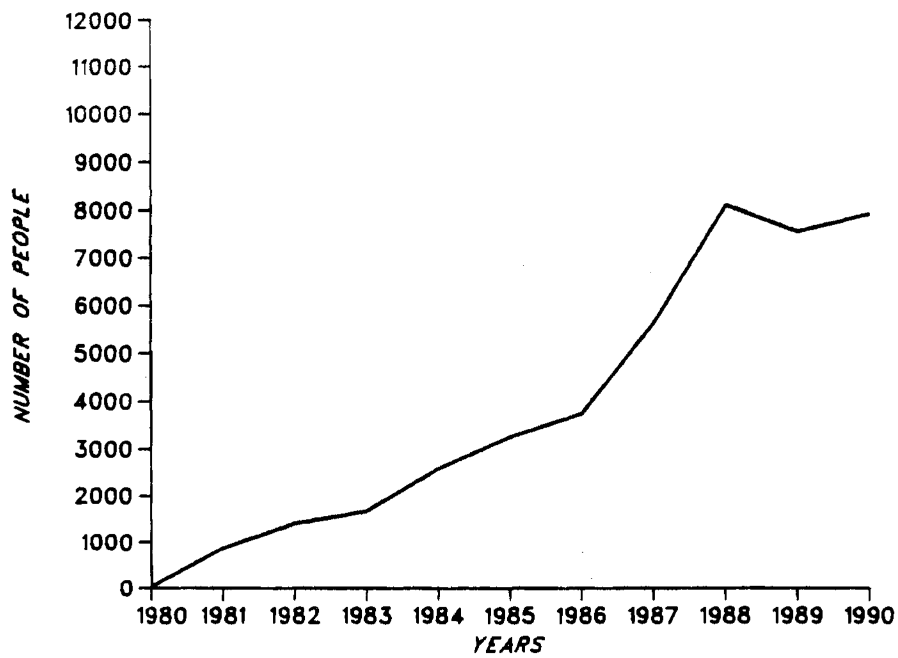

Fig. 8. Scenario-induced population growth: Meeker.

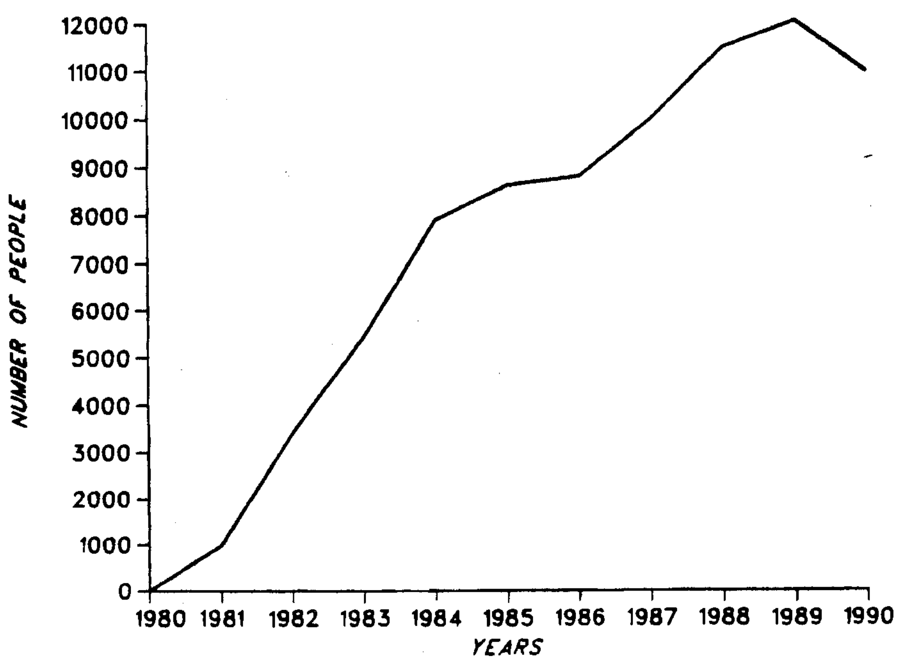

Fig. 9. Scenario-induced population growth: Battlement Mesa.

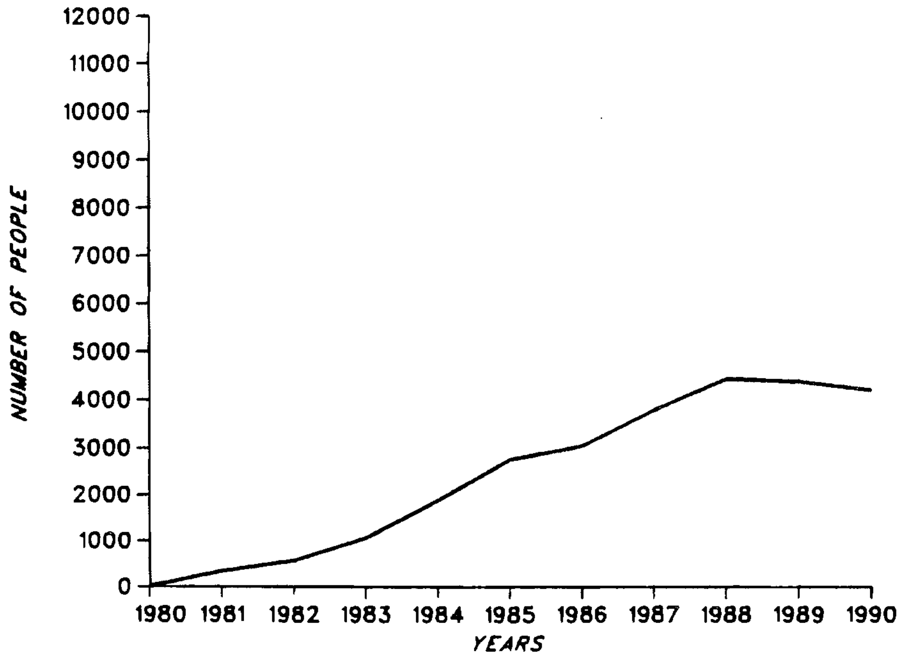

Fig. 10. Scenario-induced population growth: Rangely.

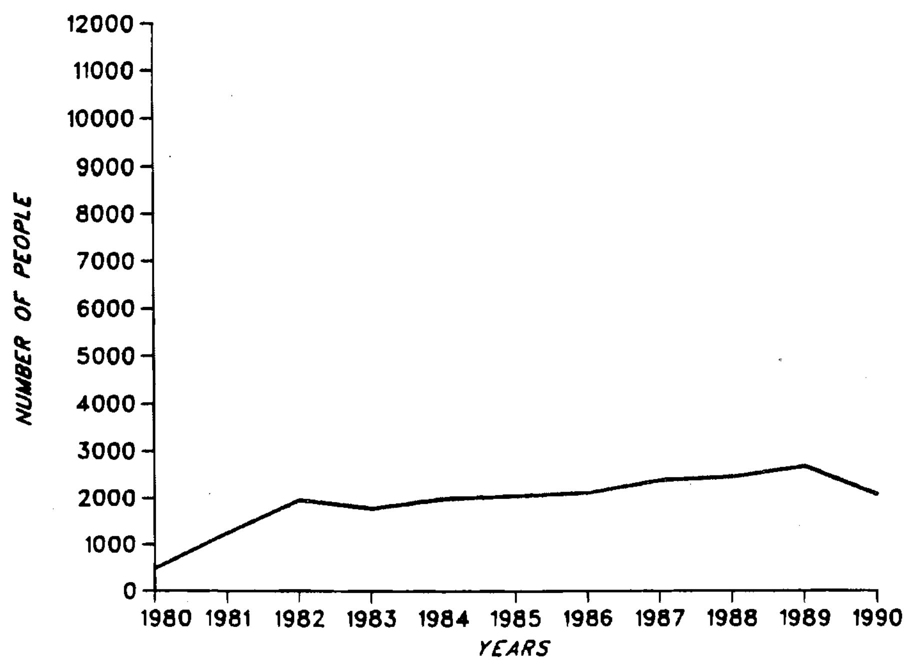

Fig. 11. Scenario-induced population growth: Grand Junction.

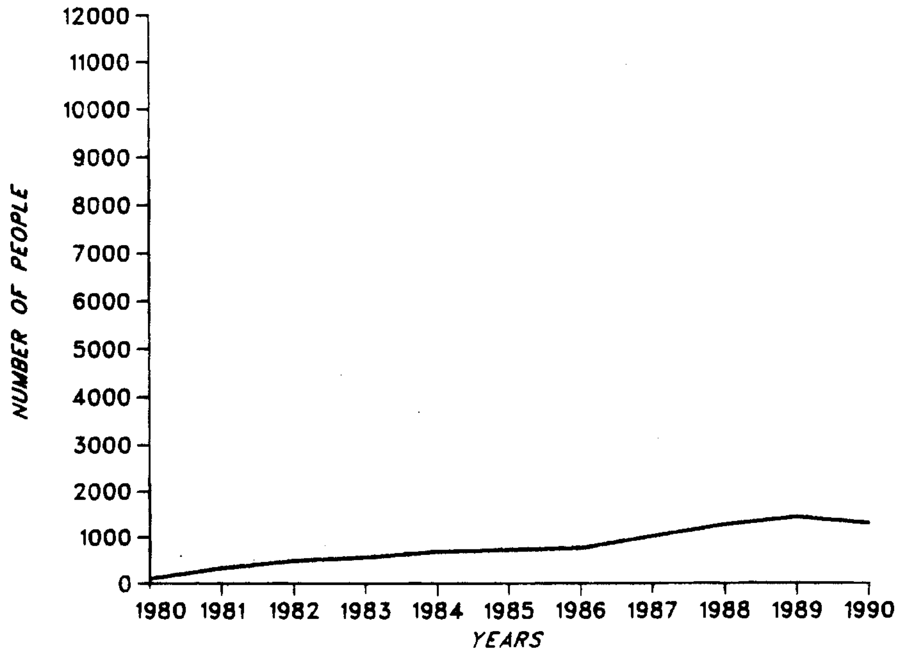

Fig. 12. Scenario-induced population growth: Glenwood Springs.

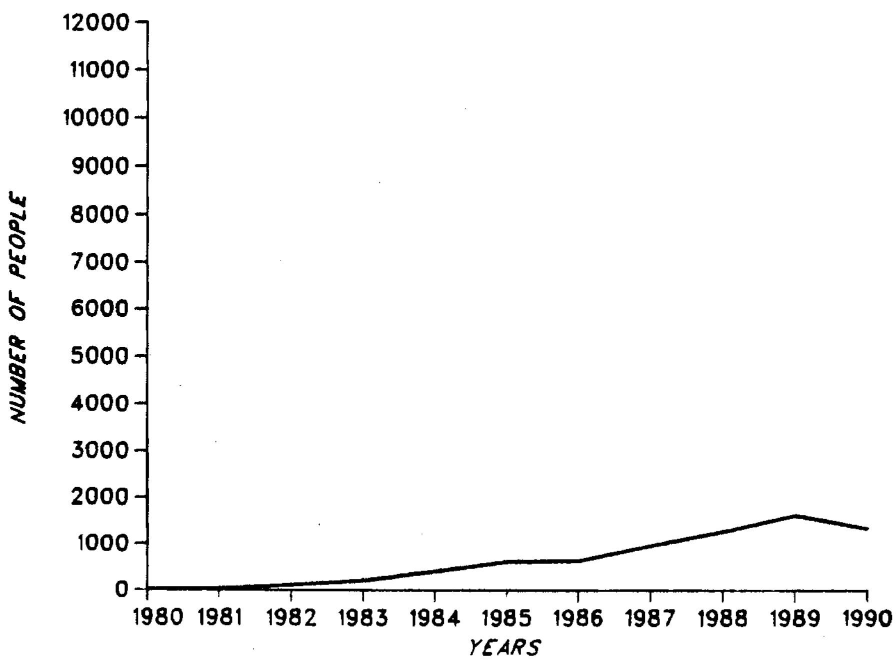

Fig. 13. Scenario-induced population growth: Craig.

TABLE XXII

SCENARIO-INDUCED POPULATION
COLORADO WEST AREA COUNCIL OF GOVERNMENTS DISTRIBUTION METHOD

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Battlement Mesa	1 242	2 329	3 528	6 199	8 184	9 662	9 703	11 302	12 574	12 359	12 858
Rifle	523	2 625	3 827	3 573	4 628	5 225	5 331	7 703	10 226	9 774	10 508
Meeker	24	483	974	1 290	2 120	3 247	3 554	4 694	6 769	6 839	6 243
Rangely	4	239	415	979	1 981	3 415	3 606	4 106	4 724	4 410	4 315
Grand Junction	257	720	859	933	1 381	1 624	1 650	1 745	2 051	2 337	1 912
Glenwood Springs	135	413	556	452	713	795	801	918	1 065	1 154	991
Craig	0	0	0	0	0	0	0	0	0	0	0
Other	556	1 751	2 512	2 680	3 569	4 103	4 092	4 986	6 001	6 254	5 689
TOTAL	2 741	8 560	12 671	16 106	22 576	28 071	28 737	35 463	43 410	43 127	42 516

Total population growth, including baseline, nonenergy-related growth, is given in Table XXIII and displayed in Fig. 14. Calculations were based on the Los Alamos distribution and indirect employment multipliers. The nonenergy-related growth was estimated by taking a linear least squares fit of US Bureau of Census populations for 1960, 1970, and 1977. The slope of the fit, representing the average annual population increment, then was employed to estimate growth starting with the 1977 Census of populations of the communities in this study (Table XXIV). This procedure should minimize the effect of recent growth in the communities caused by other energy-related industries, and should give a good representation of the nonenergy-related growth rate of the communities.

TABLE XXIII

PROJECTED TOTAL POPULATION GROWTH OF SELECTED COMMUNITIES

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Battlement Mesa	0	981	3 425	5 432	7 903	8 624	8 810	10 002	11 512	12 076	10 997
Rifle	3 388	5 020	6 350	7 021	7 522	7 937	8 306	9 294	11 205	11 366	11 181
Meeker	1 930	2 783	3 332	3 610	4 539	5 216	5 711	7 609	10 097	9 560	9 940
Rangely	1 962	2 309	2 561	3 081	3 922	4 835	5 148	5 919	6 590	6 559	6 392
Grand Junction	27 443	28 606	29 726	29 947	30 553	31 018	31 490	32 159	32 634	33 250	33 047
Glenwood Springs	4 270	4 525	4 705	4 809	4 957	5 020	5 085	5 378	5 657	5 842	5 730
Craig	7 195	7 367	7 605	7 850	8 201	8 564	8 740	9 223	9 675	10 204	10 048

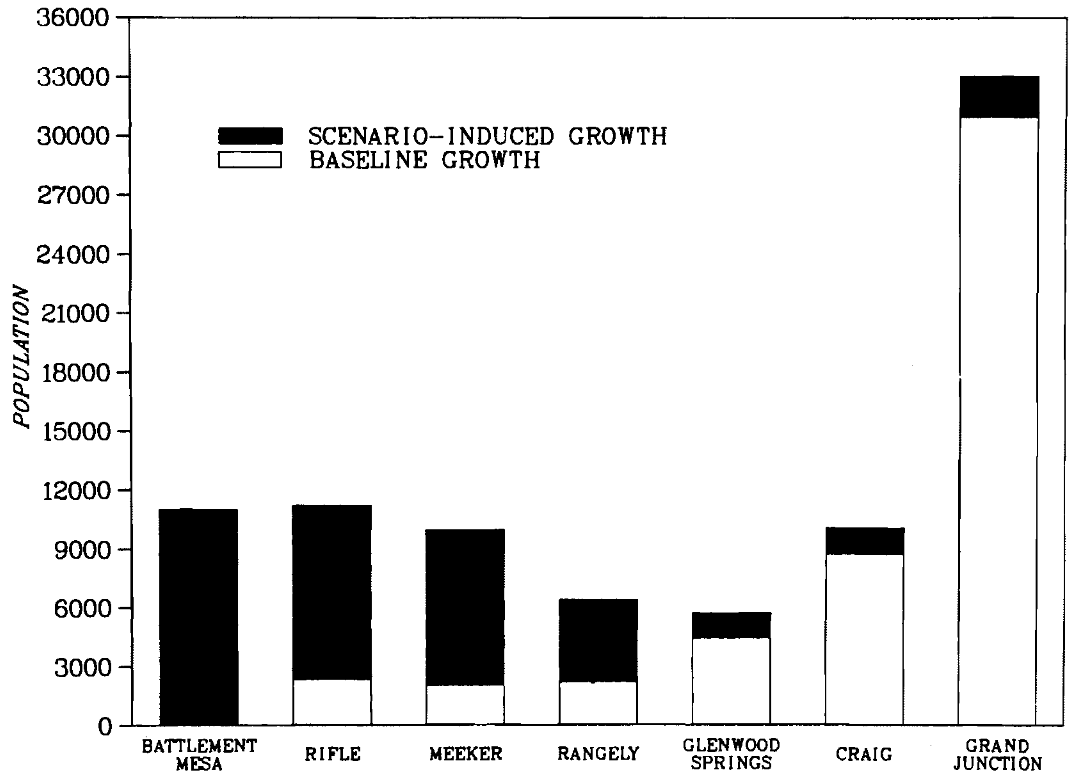

Fig. 14. Relative population impacts by 1990 for selected Colorado communities.

TABLE XXIV

ESTIMATION OF NONENERGY-RELATED POPULATION GROWTH

	April 1, 1960	April 1, 1970	July 1, 1977	Population Increase Average Per Year
Battlement Mesa	N/A	N/A	N/A	N/A
Rifle	2 135	2 150	2 248	6.24
Meeker	1 655	1 597	1 859	10.75
Rangely	1 464	1 591	1 883	23.58
Grand Junction	18 694	24 105	25 452	400.89
Glenwood Springs	3 637	4 106	4 090	27.52
Craig	3 984	4 205	6 765	152.72

V. PUBLIC FACILITIES AND SERVICES

The arrival of a large number of new residents in a small town creates an immediate need to expand existing public facilities and services. Rural communities, similar to the towns in the oil shale region, generally have stable or slowly growing populations (see baseline population estimates in Sec. IV) and seldom have excess capacity in their infrastructure to accommodate a large population influx. The negative experiences common to many of the energy-impacted rural western communities in the past have been attributed in large part to the inadequacy of public facilities and services,[1,9,24,29] which led to a general deterioration of community conditions and a degradation of the quality of life.[7,9,29,30] Worker productivity was observed to decline dramatically and the rate of turnover increased. Among the most frequently cited reasons for the inadequacy of public services and facilities in boom towns include the lack of front-end capital financing, comprehensive planning, local government expertise, and necessary information concerning the scheduling and magnitude of developments.[7,9,27,30] Consequently, estimates of public facility needs have assumed major priority in planning for rapid population growth.

The projection of public facility needs must assume certain preferences of the residents. There are several pitfalls in making those assumptions, however, particularly in the case of boom towns. Most adequacy standards for public services do not account for changing values and behavior of a population or for elasticity of demand.[6,7] The influx of a large nonlocal population, which has values and lifestyles different from the indigenous population, would influence the general public demand for services. As taxes threaten to rise, however, public demand for some services may decline. Need is not synonymous with effective demand, and provision of public services, to a large extent, is a political decision. Another problem is that adequacy standards do not generally account for <u>use</u> of services because researchers tend to assemble a set of standards that reflects the availability of service in a given community. Also, service standards frequently are applied on a per capita (or per 1000 residents) basis.

The use of a per capita standard has several drawbacks. Need and use of public services depends on residential pattern. In addition, some need for public services, such as police protection and fire protection, is not strictly dependent on population size. Finally, the services available in other nearby communities affect need for local services such as, for example, a hospital. However, per capita adequacy standards frequently are employed in socioeconomic assessments because they are simple, provide at least rough estimates of need, and allow comparison among communities or regions.

The methods used to develop these standards vary among assessments. The C-b lease tract assessment[20] based service demand on a combination of national standards taken from "The Costs of Sprawl"[23] and local interviews and studies. In the Meeker case study,[19] DRI based projections on past service levels and interviews of local officials. The THK report[24] employed a combination of national and state standards, supplemented by available information pertaining to western Colorado, although the report admitted that the actual relationship between population and service standards is probably not linear. A broad range of public service requirements is incorporated into the Social and Economic Assessment Model (SEAM) developed at Argonne National Laboratory.[31] Adequacy standards for 24 different types of communities, characterized by their size, their isolation from large urban areas, and their location across the nation, were developed by a national real estate association. The standards applied by SEAM to northwestern Colorado communities are user-specified according to the characteristics of the community.

There is even greater disagreement over costs of public services and facilities. Housing density has been demonstrated to be an important determining factor of costs, particularly for fire and police protection, schools, water and sewer systems, and roads.[23] There are differences in design and construction costs.[4] Some facility costs reflect policy decisions, such as requiring passive solar heating capacity in public buildings (recently required for the Craig city hall and the Rifle senior citizen center). In addition, inflation of land values, typical in western boom towns, reflects the nature of growth management policies and affects costs of site acquisition. Competition for labor and materials in boom towns may inflate costs of public facilities, and will vary with the size of the town, availability of labor and materials, and proximity to regional transportation and large supply centers. As stated in one report, the features of a particular site or community substantially affect the magnitude of any of the costs.[32]

The importance of cost differences between sprawl development and new town development was emphasized in the assessment of the C-b lease tract impacts.[20] Based on specified service standards, this assessment concluded that the per capita front-end capital costs for public services were $5751 (1975 dollars) for managed expansion of existing towns, $6296 for sprawl development, and $8400 for development of a new town. DRI pointed out that cost estimation methodologies "are still quite primitive,"[33] yet presented a detailed analysis of public costs in Meeker in its demonstration methdology. Only certain costs were projected on a per capita basis, and every effort was made to account for increased costs of providing services to newcomers. Interviews with local officials were an important element of this study. Capital expenditures were estimated on the basis of a population-serving threshold approach--new or expanded facilities were projected only as existing excess capacity was exceeded. From a sensitivity analysis using a standard per capita cost approach, DRI concluded that "a change in an . . . endogenous variable creates a wide range of results . . . ."[34] Peak expenditures using the per capita figure were approximately one-half those calculated with the DRI demonstration methdodology.

The per capita county capital costs used in the DRI sensitivity study were $1156, the Meeker municipal costs $2382, and the school district costs $2286, for a total of $5824 (1977 dollars) including county roads and bridges ($616). The THK capital cost estimates total $3 007 805 per increment of 1000 persons.[24] Streets were considered separately ($1 268 000 per 1000 persons). In its third annual report to the Colorado Legislature in 1980,[15] the State Department of Local Affairs based capital cost projections for public services and facilities on per capita service standards. The per capita capital costs totaled $4725 (1979 dollars). In its fourth annual report, local government (city and county) capital costs were estimated to be $10 790 000 per 1000 persons (1980 dollars).[35] A comparison of the costs discussed above is contained in Table XXV.

We have calculated capital expenditures implied by the scenario-induced population in Colorado (Sec. IV), using the 1980 state per capita cost estimates. Our calculations are shown in Table XXVI. If capital costs of providing public services in Battlement Mesa are internalized by the company, total regional costs are substantially lower. In addition, accounting for existing excess capacity in local water and sewage treatment facilities (Table XXVII) also would lower these figures. However, the 1980 State figures are the lowest of the estimates presented. Furthermore, accounting for local conditions, locally perceived needs, boom town inflation, or use of one of the

TABLE XXV

COMPARISON OF PER CAPITA COST ESTIMATES
CAPITAL EXPENSES ONLY (EXPRESSED IN 1980 DOLLARS)

C-b	$8 109	not including county roads
DRI (1977)	7 222 6 458	including county roads not including county roads
THK (1973)	8 096 5 565	including streets not including streets
State (1980)	4 961	not including roads
State (1981)	10 790	including county roads

SOURCES: "Oil Shale Tract C-b Socio-Economic Assessment: Volume II Impact Analysis," C-b Shale Oil Project (March 1976).

"Socioeconomic Impacts and Western Energy Resource Development Volume III: Case Studies," Denver Research Institute and Resource Planning Associates (June 1979).

"Impact Analysis and Development Patterns for the Oil Shale Region: Mesa, Garfield and Rio Blanco Counties, Colorado," Colorado West Area Council of Governments and The Oil Shale Regional Planning Commission, Denver (February 1974).

"Third Annual Report to the Colorado Legislature 1980, Summary and Status Report of the Mineral Lease and Severance Tax Fund," prepared by The Division of Energy and Mineral Impact (January 1980).

"Fourth Annual Report to the Colorado State Legislature 1981, Summary and Status Report of the Mineral Lease and Severance Tax Fund," prepared by the Division of Impact Assistance (January 1981).

TABLE XXVI

ESTIMATES OF CAPITAL EXPENDITURES FOR PUBLIC INFRASTRUCTURE
(EXPRESSED IN 1979 DOLLARS)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Total population	2 637	8 468	13 417	16 677	21 633	24 745	26 232	32 155	39 558	40 649	38 303	
Change in population	2 637	5 831	4 949	3 260	4 956	3 112	1 487	5 923	7 402	1 091	-2 346	
Incremental capital costs (millions of $)	12.46	27.55	23.38	15.40	23.42	14.70	7.03	27.99	34.97	5.15	-	192.05
Population of Battlement Mesa	0	981	3 427	5 432	7 903	8 624	8 810	10 002	11 512	12 076	10 997	
Incremental capital costs if Battlement Mesa population excluded (millions of $)	12.46	22.92	11.83	5.93	11.74	11.30	6.15	22.35	27.84	2.49	-	135.02

TABLE XXVII

POPULATION-SERVING CAPACITIES
OF SEWER AND WATER TREATMENT SYSTEMS

	SEWER[a]			WATER		
Town	Present Capacity	Future Capacity	Stage of Development	Present Capacity	Future Capacity	Stage of Development
Craig	10 000	20 000	planned	14 200[b]	25 000[b]	planned
DeBeque	65	900	funded	250[b]	1 200	under construction
Dinosaur	600	--	--	425[b]	--	--
Fruita	3 200	10 600	planned	3 000[c]-3 240[b]	7 500[c]	planned
Glenwood Springs	3 750	12 500	under construction	14 400[d]	14 400[d]-22 200[c]	--
Grand Junction	67 000	120 000	planned	40 000[c]	--	--
Parachute	450	2 500	planned	400[c]-450[d]	1 400[d]-2 000[c]	planned
Meeker	6 000	8 000	funded	4 000[c]-4 850[b]	8 000[c]	funded
New Castle	1 000	2 500	early design	1 000[d]	2 000[d]	early design
Palisade	4 500	10 400	planned	5 000[c]-5 700[b]	8 325[c]	funded
Rangely	10 000	20 000	planned	6 500[d]-10 000[c]	--	--
Rifle	3 500	10 000	under construction	4 000[c]-6 000[d]	12 000[d]	to be completed 1980
Silt	550	2 800	early design	1 000[d]	2 800[d]	early design

[a]Colorado West Area Council of Governments' Memorandum, March 1980.

[b]"Regional Profile Energy Impacted Communities Region VIII," (assuming 350 gallons per day per person) DOE/TIC-10001, US Department of Energy, Office of the Regional Representatives, Region VIII (Denver 1979).

[c]Community growth capacity inventory, Colorado West Area Council of Governments.

[d]Communication from Garfield County planner.

other estimating procedures could increase these figures. None of these estimating procedures specifically accounts for economies of scale, as does SEAM, which calculates the total capital and operating costs for both the peak year population and permanent population. The incremental costs per capita can be derived from these totals and provide a measure of the relative severity of socioeconomic impacts.[36]

Another measure of impact severity can be shown by comparison of projected public expenditures for specific points in time, generally for the peak population year or for the permanent population (for example, as SEAM forecast expenditures). However, annual projections reveal the most serious fiscal problem that faces local governments in energy impacted communities, the so-called tax lead time. As many studies have pointed out, the revenues generated by the new tax base are not realized until several years after the initial requirement for massive amounts of capital to expand or build new public facilities. This revenue shortfall was shown in the "Tax Lead Time Study" to persist 5-8 years after the onset of the oil shale "boom".[37] The population impacts projected in this study were 24 345 for Rio Blanco County, 40 124 for Garfield County, and 157 335 for Mesa County. Projections for Rio Blanco County and Garfield County indicated a maximum deficit of about $15 million in each county. These counties would experience revenue surpluses only after seven or eight years, assuming no change in existing revenue structure. Deficits in Mesa County, however, were shown to increase through the last year of the projection when they would exceed $2 million, although these deficits may have been overstated by the failure to consider sales tax revenues from out-of-county residents. The projections were based on an annual per capita revenue of $428, per capita operating expenditures of $500, and a 1% sales tax for all three counties.

In the same study, the revenue-expenditure balance for the three-county region revealed a revenue surplus of $28 million in the last year of the projection. The analysis indicated that the oil shale industry would ultimately generate revenues to cover public expenditures, but that initial short-falls would occur, and that jurisdictional mismatches might create enduring deficits. The "Boom Town Financing Study"[38] concluded, in addition, that school districts would best be able to generate necessary capital funds, and that municipalities would encounter the worst difficulties generating necessary front-end capital because the population influx would not be accompanied by a corresponding increase in the tax base. All planned oil shale facilities are located in remote parts of the region, well outside of municipal boundaries.

The results of the Meeker case study, reported by DRI,[19] upheld the conclusions discussed above. Capital shortfalls were projected through year 13 for both Rio Blanco County and Meeker. The estimated population associated with the DRI energy development scenario increased to 23 969 by 1990, year 13 of the projection. Meeker's deficit was estimated to be $3 529 000 by year 13 (1977 dollars), whereas the county's deficit would reach $11 774 000. The school district received surplus revenues of $26 441 000 by year 13. Although substantial detail has been incorporated into this fiscal analysis, the report cautioned against treating the results as absolute dollar figures.

The quantity that these studies have attempted to measure is fiscal capacity, perhaps the most important determinant of public expenditures.[39] Fiscal capacity of a local government can be described as its ability to finance capital expenditures and can be represented as the difference between projected revenues and operating expenditures. The accuracy of operating expenditure forecasts, as discussed earlier in this section, depends on assumptions of public demand for service. The accuracy of revenue forecasts heavily depends on the detail of the analysis. Substantial variation exists in the revenue profile of the towns and counties in the study region. Rio Blanco County, for example, currently has one of the lowest mill levies in the state, receives the maximum $200 000/year from oil shale lease-hold royalties, and has an assessed valuation of $223 million. Mesa County, on the other hand, contains no oil shale lease tracts, has an assessed valuation of $279 million, and has a population more than ten times larger than that of Rio Blanco County. Although a detailed fiscal analysis is beyond the scope of this report, the results of some demonstration runs using a state fiscal capacity evaluation model are described below as an illustration of the problems.

The model[40] estimates future revenues and operating expenditures from user-specified population projections and financial standards. The financial standards describe the tax structure and operating expenditures of a community in relation to all other communities in the state.

The Colorado Division of Local Governments has assembled data on revenue sources, operating expenditures, and population size for every community in the state. A "typical" financial standard, based on the relationship of revenue sources and operating expeditures to population size, is estimated for each year by a least squares regression of the data. Thus, the financial standards of a particular community can be described as a percentage of the calculated "typical" standard. A large assessed valuation of a specific community, for example, might be represented as "140% of base" by the model, indicating that the assessed valuation is 140% that of the model-defined norm.

On the basis of user-specified parameters and local government financial data stored in the model, the model can project future capacity to generate property tax revenues, sales tax revenues, intergovernmental revenues, and revenues from charges, licenses, permits, fines, and franchise taxes. Plotted against projected operating expenditures, the amount of surplus revenue generating capacity can be shown. Capital needs, identified by the user, can be plotted against capital capacity to illustrate the fiscal calculations performed by the model. The model may be applied to several types of local jurisdictions, including counties, municipalities, water and sewer districts, and school districts. The fiscal capacities of the municipalities in this study were assessed using the state fiscal evaluation system. Population projections were determined by the population impact analysis described in Sec. IV. Where baseline adjustments were necessary, the current population contained in the model's data base was selected. Financial standards for the fiscal capacity projections were determined by current revenue profiles and levels of service were held constant. Specifically, the average of the two most recent years was employed. The 1978 sales tax rate was held constant for the decade. Capital needs were calculated using the 1980 Colorado Department of Local Affairs' standards and costs discussed earlier in this section, excluding water and sewer, for the same year as the population increment. Neither funding mechanisms nor cost changes as a result of inflation were considered.

The results of these model runs are shown in Figs. 15-20. Deficits in 1981 and 1988 were estimated to be $4 551 000 and $4 717 900 in Rifle. The dramatic drop in capital needs at the end of the decade reflects the declining rate of population growth. The 1988 deficit in Meeker was projected to be $7 017 300, a much larger deficit than projected for Rifle in spite of the smaller population growth (Table XXI in Sec. IV). The difference can be attributed largely to the different sales tax rates and taxable retail sales

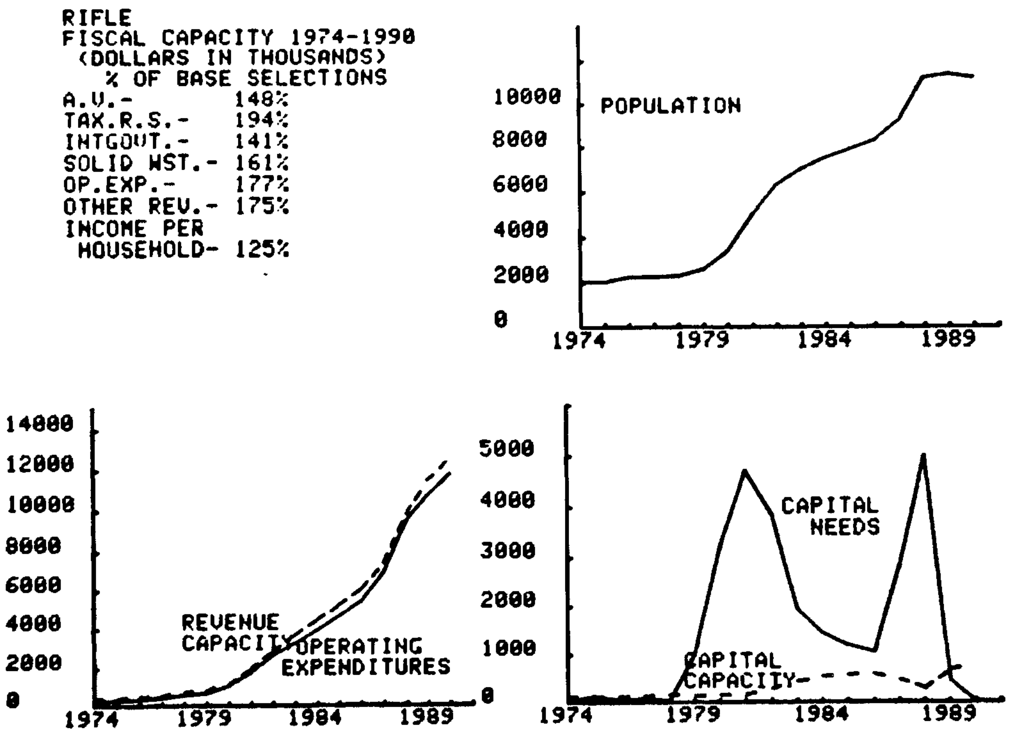

Fig. 15. Projection of fiscal capacity: Rifle.

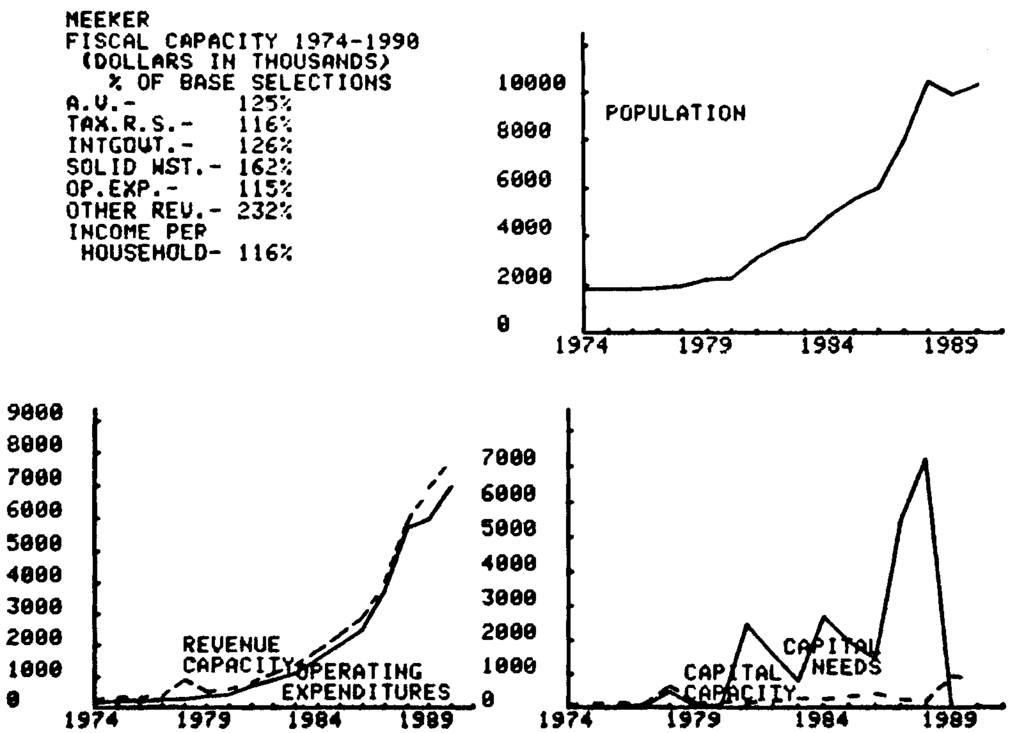

Fig. 16. Projection of fiscal capacity: Meeker.

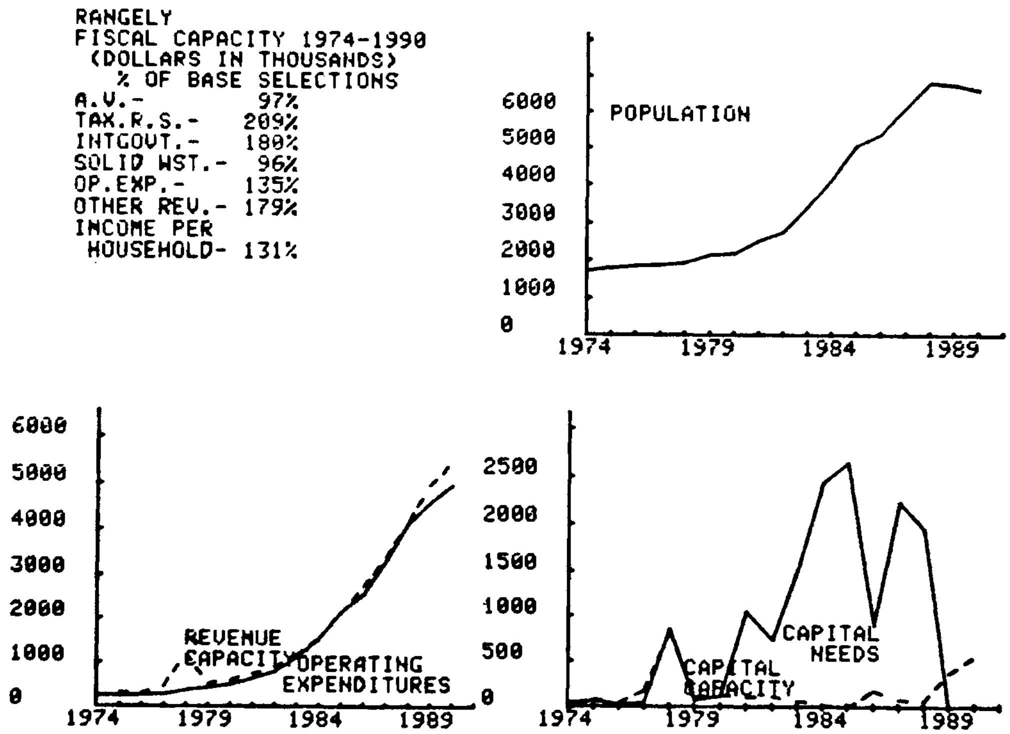

Fig. 17. Projection of fiscal capacity: Rangely.

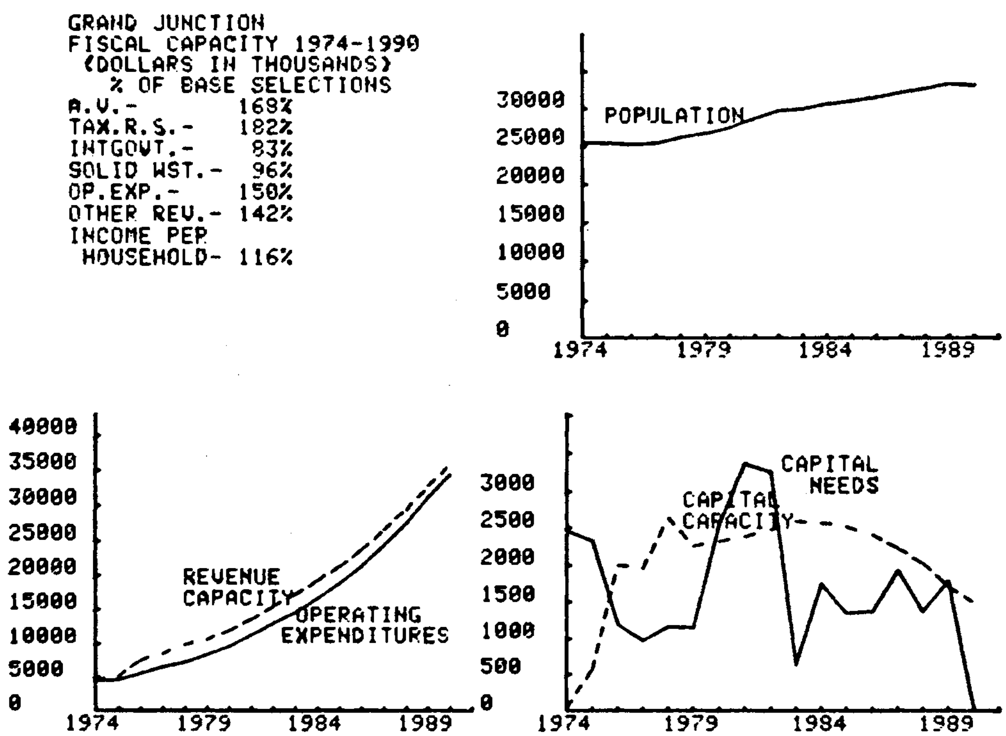

Fig. 18. Projection of fiscal capacity: Grand Junction.

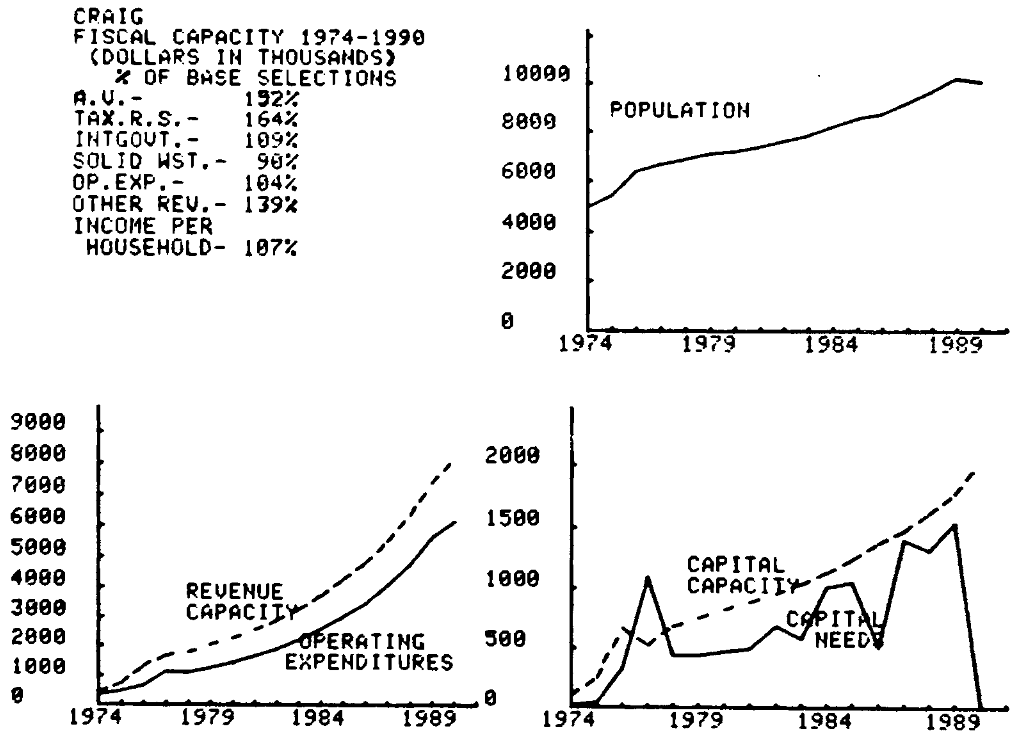

Fig. 19. Projection of fiscal capacity: Craig.

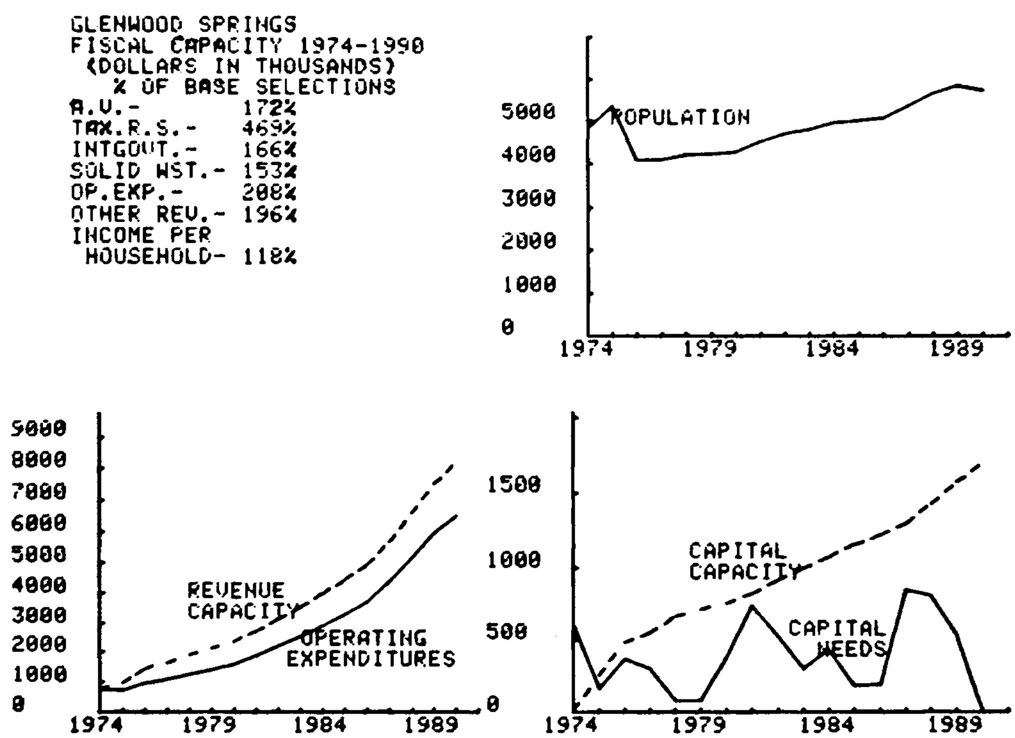

Fig. 20. Projection of fiscal capacity: Glenwood Springs.

in those towns. Rifle's 2% sales tax provided more than half the municipal revenues in recent years, while revenues from the 1% sales tax in Meeker provided approximately one-fourth of municipal revenues.

The model results indicated that scenario-induced population impacts in Rangely would create a deficit of $2 649 800 in 1985. The estimated revenues of that year, moreover, would not cover projected operating expenditures. The impacts in Grand Junction, Craig, and Glenwood Springs were estimated to be substantially less, although capital capacity in Grand Junction was projected to fall short of capital needs in 1981 and 1982 by $966 000 and $753 200. As shown in Fig. 18, Grand Junction's taxable retail sales were estimated at 182% of base. As shown in Table XXI (Sec. IV), we estimated that the greatest scenario-induced population growth in Grand Junction would occur in 1981-1982. Consequently, the additional fiscal capacity projected for Grand Junction after 1983 is a reflection of the low population growth rate. Deficits might occur if Grand Junction were to grow as a regional trade center, the increased retail sales would provide substantial revenues. Revenues from sales tax have constituted more than half of municipal revenues in recent years.

As done in other assessments, we must emphasize that these figures should not be viewed as absolute levels of need. They are shown to illustrate the potential need for external financial assistance in these communities and/or changes in fiscal policies. The revenue and expenditure projections were based on existing tax structure, population estimates, assumptions of service level, standardized cost estimates, and existing state tax laws, all of which are dynamic variables.

Changes in fiscal policy could drastically alter the revenue picture.[36,37,38,41] Existing fiscal policies have been criticized for handicapping local government. In Colorado, these include the present municipal debt ceiling of 3% total assessed valuation, county debt ceiling of 1 1/2% total assessed valuation, the 7% per year limit on state and local budgets, and the constitutional ban on issuance of general obligation debt. In addition many proposals have been advanced to provide front-end financing for construction of needed public facilities. These include establishment of a head tax on nonlocal workers to be paid by the employer, a use tax, redesigned utility rate structures, revenue sharing among all levels of local government, prepayment of severance and ad valorem taxes, use of monies in (and/or the interest from) the state's Oil Shale Lease Fund for impact assistance, tax increment financing, and provision of Federal assistance through existing channels and new legislation. Some of these proposals have been adopted, and millions of dollars already have been provided for capital expenditures in the communities that anticipate impacts from oil shale development (Sec. VIII).

The delay of the expected development of a commercial oil shale industry has provided several years in which revenue sources have been identified, issues of equity explored, and mechanisms for awarding assistance established. The state has initiated efforts to assemble and update public facility capacity data for communities throughout the state, has established a Cumulative Impact Task Force to examine impact forecasting methodologies and financing mechanisms, and has developed several in-house computer models to assist impact forecasting. However, there is little agreement among Federal, state, and local government officials as to who should pay. Clearly, government at all levels has recognized that fiscal policy should be regarded as an interactive tool that can be used to effect change. Questions of equity, however, continue to handicap attempts to develop comprehensive fiscal programs that would release local government from the present perennial duties of grantsmanship.

VI. HOUSING

One of the most critical problems in periods of rapid population growth is the supply of adequate housing. Lack of adequate housing has aggravated the negative aspects of accelerated growth in many energy-impacted communities, and the problem has been described as a major contributing factor in the reduction of worker productivity and increased worker turnover.[36,40,42] Both effects lead to a greater number of workers than estimated. Inadequate housing contributes directly to individual and family problems and reduces the ability of the community to attract new residents, especially professionals and public employees required to support the community. Consequently, supply of the necessary amount and type of housing is crucial to the successful development of a population-intensive industry such as oil shale.

For many reasons, adequate housing has not been available in energy boom towns. Among the most important of the factors mentioned in case studies and previous socioeconomic assessments is the uncertainty that surrounds energy development. Construction schedules of energy facilities are subject to many changes that stem from technology or economic changes or arise through the permitting process required under existing environmental regulations. Delays in the onset of construction may span years, thus obviating any planning efforts. In addition, much uncertainty is involved in the estimation of work force requirements. In the classic example of Rock Springs, the construction work force for the power plant was nearly double what the company had originally estimated because of a dramatic decline in worker productivity during the course of the construction phase.[29] In the case of large commercial oil shale facilities, the work force requirements remain to be confirmed by experience. Further uncertainty lies in the number of family members who will accompany energy workers (Sec. IV). A recent study, for example, reported that the provision of bachelor quarters for construction workers has a direct impact on the ratio of workers accompanied by their families to those who are not, and lowers the overall average household size of the work force.[27] Finally, energy projects are vulnerable to national policy decisions and changes in the international trade situation. The history of US oil shale development, in particular, reflects national policy. All of this uncertainty translates directly into risk that must be assumed by investors. Consequently, developers are unwilling to build before the demand for housing exists, and are reluctant to do so when the possibility of a bust is great.[43]

Another important reason for the lack of adequate housing has been the shortage of materials, labor, and capital. Energy development has adversely affected small, isolated, rural communities that cannot generate adequate capital to finance a sudden increased demand for housing and cannot provide sufficient labor for housing construction. Labor shortages are further exacerbated by competition from the energy facility. To provide housing, outside developers must be brought in.

Land speculation, in addition to labor and materials shortages, drives up the cost of housing in boom towns, while lack of mortgage money reduces the number of persons able to purchase housing. As a result, people are drawn by the need for shelter to live in tents or campers and to rent motel rooms by 8-hour shifts. Mobile homes are attractive alternatives to those who can afford them. During the boom in Gillette, Wyoming, for example, more than 50% of the new housing was in the mobile home category.[43] Typically, mobile homes are cheaper to purchase and have lower financing payments and property taxes. Mobile home parks can be designed as very desirable living environments and planned with foresight, as was the Black Mountain subdivision in

Wheatland, Wyoming, in which the lots were prepared for single family housing to be constructed after the peak of the construction phase. However, during the confusion and pressures of unplanned growth, mobile home parks have grown up on the periphery of towns, with inadequate utilities and few services or amenities.

The lack of community infrastructure is another important reason for inadequate housing during periods of rapid population growth. Water and sewer systems quickly reach capacity and are expensive to upgrade and expand.[36] As discussed previously, communities must have sufficient leadtime and capital to construct such facilities before the new population arrives. Obviously, the community also must have reasonably accurate information on expected population growth to define its needs.

In the early oil shale assessments, estimates of required housing were based strictly on assumptions of worker preferences.[20,24,44] These preference assumptions often were based on the results of the worker survey reported in the "Construction Worker Profile,"[26] which indicated that 46% of newcomer construction workers, 70% of the other newcomers, and 87% of long-time residents preferred to live in single-family housing. Respondents who would have been willing and able to purchase single-family housing constituted 34% of the newcomer construction workers, 55% of the other newcomers, and 81% of the long-time residents.[45] However, this report also suggested that people's dissatisfaction was concerned with the <u>cost</u> of housing rather than its availability.

More recent assessments have tried to deal with the cost of housing by attempting to calculate the demand for housing that is actually affordable--the effective demand for housing. The DRI has developed a methodology for estimating effective housing demand that entails

- projection of the numbers of households by income group,
- estimation of housing costs,
- translation of housing costs into income requirements, and
- estimation of effective housing demand.[46]

The result of these calculations provides an estimate of housing demand that accounts for personal income limitations and cost of housing. The category of "residual demand" represents the numbers of households whose "incomes do not qualify them for any of the housing prototypes using the standard housing financing assumptions."[47] The magnitude of residual demand estimated by the DRI methodology provides a measure of the adequacy of housing supply for a given scenario; residual demand indicates a failure of the private housing market to meet new housing demands.

The COG employs a similar methodology to estimate housing demand. Several sets of assumptions within the framework of this methodology lead to a distribution of new housing units by income group. For example, separate assumptions characterize basic and nonbasic worker preferences, peak years demand, housing needs of the elderly, and availability of housing in Meeker.

In the description of both methodologies, institutional constraints to the supply of housing are explicitly addressed. Neither methodology, however, has incorporated these constraints into a quantitative estimate of housing availability. As discussed above, among the most important factors that affect housing supply are

- the existence of community infrastructure (the capacity and location of streets, water, and sewer systems),
- the availability of financing,
- the availability of construction labor and materials,
- the existence of local housing entrepreneurial skills, and the perception of risk.

A detailed representation of these supply constraints has been incorporated into BOOMH, a simulation model developed at Los Alamos.[48] Although the model is not expressly designed to forecast impacts on a specific community or county, the model allows the effectiveness of many housing policies to be tested. Policy proposals that have been examined with the model include

- loan guarantees to local government,
- construction grants to local government,
- financial assistance to housing developers,
- loans to lenders to provide lower interest mortgage funds to local banks,
- reduction of delays and costs of obtaining approval of developments,
- land assembly to assist with housing development,
- reduction of inflated construction costs by use of modular housing, and
- prebuilding of permanent housing by the energy company or by government.

The results of model runs have provided some insight into the interplay of specific housing supply and demand constraints characteristic of boom town conditions. The use of modular housing, relaxed regulations, land assembly, and financial aid to developers, for example, were shown to eliminate the boom-induced inflation of housing costs. On the other hand, even the implementation of supply-oriented policies may not overcome the negative effect of risk, and an adequate supply of housing may only be guaranteed through intervention by the state or Federal Government or by the energy company.[48]

Intervention by the energy company has already been attempted in western boom towns. In Beulah, North Dakota, bachelor quarters have been built for construction workers, thus alleviating the population pressures of accompanying families, improving worker productivity, and reducing turnover.[27] Fewer negative impacts are felt by the community. Although some local business may prosper, the bulk of workers' income may be sent back to families residing out of the county or state; thus the money is removed from the local economy.

Atlantic Richfield Company (ARCO), previously joint owner of the Colony Development Operation, built an entire community in Wright, Wyoming, to accommodate the housing needs of its workers. Before recently selling its Colony interests to EXXON Company USA, ARCO, in conjunction with TOSCO, developed plans for a new community to be built near Parachute that would house as many as 21 000 people. EXXON and TOSCO have proceeded with the construction of this community. Officials in Garfield County described this new community, Battlement Mesa, to be their one greatest salvation in being able to cope with the oil shale boom. Infrastructure will be provided by industry and housing will be built by private developers. Schools built with funds from Union Oil Company of California and EXXON will be leased to the community at a nominal fee until the assessed valuation of the community allows for the purchase of schools. These oil companies believe the investment in healthy living conditions for future employees will sustain high worker productivity and reduced turnover.

Although housing developments at Battlement Mesa will reduce pressures on other markets, a substantial amount of new housing will be required throughout the region. According to the Garfield County Planning Director, more new housing units were approved in all of Garfield County in 1979 than in any previous year.[49] The August 1979 C-b monitoring report listed many new housing subdivisions under development in both Meeker and Rifle.[48] The total number of planned new home lots, according to the August report, was 703 single-family lots and 229 multifamily lots, most of which were zoned for duplexes or four-plexes. Not all of these lots have been built on and construction of new housing units has been planned to meet demand. Housing costs reflect inflationary tendencies, however. The median sales price of a single-family home in Rifle increased from $49 500 to $58 000, an increase greater than 17% from 1978-79. Personal interviews with new Rifle residents indicated that apartments are scarce and very expensive to rent. Employees of the C-b oil shale venture have indicated their housing preferences would be to live in single-family housing (78%), whereas only 10% indicated a preference for mobile homes and 12% for apartments.[50] Nevertheless, the survey revealed that only 48% of the workers rented or owned single-family homes, 20% rented or owned mobile homes, and 25% lived in apartments. Furthermore, 7% lived in recreational vehicles or motel rooms.

According to the 1979 DRI case study of Meeker,[19] Rio Blanco County has had to rely on outside developers and capital for construction of new housing. Garfield County, on the other hand, has been able to support some local developers although not to the extent that Mesa County has. Of all three counties, DRI reported, the housing supply is greatest in Mesa County.

If the oil shale industry develops as described by the DOE Scenario (Sec. III), more than 8100 new households will enter the regional housing market by 1985 and an additional 4600 by 1990 (assuming an average of 2.75 persons per household). If only half of these people were to purchase single-family houses at the 1979 median sales price reported in Rifle, $261 million of mortgage capital would be required by 1985 and a total of $404 million by 1990. Therefore, a great deal of mortgage capital will be required to make housing available. There is some concern that availability of mortgage capital will prove to be a greater problem than construction of an adequate number of houses.[51]

In conclusion, provision of adequate housing is likely to be a serious problem if oil shale commercialization occurs in this decade. Although the availability of labor and materials and the existence of mechanisms to alleviate housing finance problems will affect housing construction, perception of risk may be the most important determinant of housing supply. A national policy commitment to the oil shale industry may be necessary to change this perception. In the absence of such a commitment, oil shale companies may wish to attract outside developers to the region to provide housing for their workers or sponsor new towns as in the case of Battlement Mesa.

VII. SOCIAL IMPACTS

Rapid growth in western towns is not a new phenomenon; it dates from the 19th century's gold rush boom towns. Those communities grew almost overnight and many disappeared nearly as rapidly. More recently, rural communities in the Rocky Mountain States have been affected by rapid growth stimulated by the development of energy resources in the region. The advent of a commercial oil shale industry in western Colorado offers the prospect of rapid population and economic growth that may alter dramatically the traditional social bases of established western rural communities.

Growth generated by oil shale development will bring changes in the communities' culture, social structures, and institutions.[30,52] Reports on other western boom towns suggest that, unless effective strategies for managing these changes are conceived and implemented, these alterations can lead to high levels of individual stress, a deterioration of sense of community, an increase in social disruption, greater work force turnover, and an eventual lowered productivity in the oil shale industry. The following discussion will focus on factors that lead to these human problems of rapid growth and the development of mitigating measures by the community and industry. Specific approaches will be addressed, including techniques to reduce potential negative impacts and programs designed to strengthen the evolving community.

The disruptive effects of rapid change on the social systems of small rural communities have been well documented. A study of Craig, Colorado, during its period of greatest growth (1976) noted dramatic increases in drug and alcohol abuse, family disturbances, child behavior problems, and crimes against persons.[53] The rate of increase substantially exceeded the growth rate of the community, and the data suggest that the problems were nearly evenly divided between long-time resident and newcomers.

Certain groups within the community seem particularly vulnerable to rapid community change--women, the aged, and children. For women, these consequences may include a loss of both public and private status, a restriction to primarily volunteer work, or generally low wages for work that is similar to that performed at home.[54] Also, the elderly tend to be the forgotten victims of energy resource development because they do not readily appear in the caseload statistics.[55] Among the sources of stress experienced by the aged are fixed incomes that cannot keep up with cost of living increases, scarce and expensive housing, less access to adequate health care, and a sense of losing their community of reference. Many of the stress factors known to be present in instances of child abuse face both children and their parents.[56]

The unique characteristics of western rural communities may be determining factors in their ability to accommodate the changes created by rapid growth. Purrington describes rural societies as being "characterized by ethnic groups with pride in history, region, identity, values, and rural status."[57] Three factors appear relevant to the understanding of social disruption in western rural boom towns: geographic isolation, the informal nature of communication and support networks, and the characteristics of the residents.

Most of the communities in the oil shale region are both physically and psychologically isolated from each other. The mountain ranges, severe winter weather, and long distances between towns tend to encourage a strong sense of separateness and self-reliance. Each town attempts to provide a full range of primary public facilities and services and looks outside its own capacities only for infrequent and secondary needs. Choice and availability of personal services are limited, and residents become accustomed to living without many urban amenities such as supermarkets, discount stores, and a variety of restaurants and means of entertainment. Newcomers, particularly those from urban areas, can find the isolation and lack of formal and institutional services stressful.

The second factor is that rural communities have developed long-standing informal social support and communications systems created through many years of interactions. These informal systems are necessary in a community with few formal institutions and an historic reliance on word-of-mouth communication. Newcomers are often unaware of this process. As a result, they are isolated from the information that could enable them to identify and to utilize existing informal support networks effectively.

Third, the characteristics of the residents themselves may affect the acceptance of newcomers. The rural westerner still values the "rugged individualist," and maintains a strong belief in the attributes of independence and self-reliance. He tends to be cautious about entering into new social relationships and may be wary of strangers and guarded when associating with them. Some of the long-time residents, who choose to live in these rural communities to avoid the very issues that new urbanization poses, may be particularly resentful of the change. The newcomers have not chosen to come because of similar values and ideals, but rather because of resulting economic benefits. Unless these dynamics are recognized and compensated for in the planning process, the social accommodation of growth and change may be among the more difficult issues faced in the development of a substantial oil shale industry.

A change-stress model leading to maladaptive coping mechanisms is useful to understand social disruption in these communities. Any change, whether positive or negative, may lead to stress and increase an individual's susceptibility to many types of illness.[58] A study conducted by the National Institute of Mental Health concludes that rapid change and/or community instability may be correlated with an increased risk of mental illness.[59] During the Gillette, Wyoming, boom of the 1970s, residents reported stress related to changes in living conditions, work, financial status, deficits in community services, and the demands of adjusting to life in a new community.[60]

Among the first specific stresses faced by residents of a boom town are the anticipation and perceptions of the impending change. Cobb states that "anticipation of change may, in fact, produce more severe and/or different patterns of symptomatology than change itself."[61] With the problems of other boom towns being well publicized and with the continuing uncertainty about the actual levels of growth to be expected in the oil shale region, residents may begin to feel less secure, less in control of the destiny of their community, and may behave as if the change has actually occurred. Thus, the mere threat of rapid growth may reduce the community's tolerance of newcomers unless programs are developed to help people maintain realistic perceptions of change.

As social and institutional changes occur, the roles that individuals assume also change. New roles may be created, old roles eliminated, or traditional roles broadened, redefined, or specialized through differentiation. Both residents and newcomers may find that their previous roles have been altered, causing introspection and a need to deal with a new definition of expectations and socially acceptable behavior. To avoid the stress of these changes, individuals may withdraw from situations where interaction with strangers may be required.

As the number of changes in the community increases, the amount of stress experienced by residents is expected to increase, intensifying the individual's vulnerability. To keep up with the pace of change, the individual must regularly draw on inner reserves of personal resources. If there is limited access to community-centered support structures, there are fewer opportunities to replenish these reserves. Although most people have access to friends or small groups of familiar people who can support a sense of personal well-being, a tie of the larger community may be necessary to keep the smaller group intact. For example, the woman accompanying her employed husband to a boom community may depend on the strength of the marriage relationship alone to survive isolation for the first several months. If she is unable to develop other support within the community, she may possibly become a high risk for depression or divorce, or may force here husband to leave his job and the community to maintain the marriage relationship.[62]

Social support systems help reduce susceptibility to stress-related psychological problems by providing a refuge from the stressful environment and by assisting in the realistic interpretation of feedback.[63] Individuals who serve as a social support to another person in their network should feel needed and experience an increase in self-esteem with an accompanying decrease in helplessness. If they assist in establishing a social network, their feelings of power, control, and personal worth should increase.[53]

As there are few precedents in rapidly growing communities for government, industry, and the community to plan for social change cooperatively, such planning historically appears not to have been a significant factor in policy deliberations. In considering proposed strategies to manage change, the development and eventual success of these strategies are largely dependent on policy decisions. Key issues are

- The scope and pace of development. The growth scenario discussed in this report lends itself to potentially effective programs for managing change that are tied to community integration.
- Planning the location of growth to center around the core of an existing community or the development of a new town. Each location requires a different approach to the development of a sense of community.
- The use of lead-time. The amount of lead-time and degree of commitment to human impact planning will determine the extent to which change management programs are in place at the time of impact.

- A focus on proactive (preventive) or reactive programs. Boomtown experiences indicate that unless funding stipulations emphasize prevention efforts, available resources will be used most exclusively for reactive programming.

- The selection of a human impact planning body. Should planning and advisory authority be vested in a body external to government and industry? If so, how should that body be comprised and its authority supported and/or limited?

- The allocation of resources for change management. Who bears the cost of coping with human impacts; who determines appropriate expenditures; what is the process for negotiating responsibility?

Few rural areas, including northwest Colorado, presently have adequate formal human service structures.[64] Administrators of the agencies that do exist in the area tend to view rapid growth as creating more need for their services than their historically under-resourced programs can provide. Because traditional funding mechanisms are largely insensitive to population changes, and agencies seldom engage in community-based prevention efforts, the agencies concentrate on securing resources solely to expand and upgrade traditional reactive services. Industry may be regarded as a logical and legitimate source of funding, and therefore may be requested to fund historic deficits in addition to needs related to its impact.

Many of the formal human service needs of employees and their families can be funded through company benefit policies, including health insurance. By assuring that services are covered at their cost, industry can support their availability over the life of the project and provide nonphilanthropic long-term funding. During the lead-time before construction begins, industry and government can cooperatively plan the responsibility and allocation of resources for human service program expansion. As the tax base grows, local government may become better able to provide funding for needs not covered by employee benefits. A broad-based, local human resources planning body, composed of representatives of human services agencies and informal community caregivers, can provide industry and government with valuable assistance in this process by identifying existing resources, defining current and future problem areas, setting priorities for community needs, and making program support recommendations based on these factors.

Adequate, traditional services are essential to the continuing welfare of the community, but the experiences of modern boom towns suggest that the mere expansion of these services is not sufficient to reduce social impact.

An approach emphasizing informal helping networks can have a more substantial effect on the causes of social disruption and reduce the need for additional reactive services.

Although there has been much discussion of the potential for negative social impacts, energy-related growth in western communities need not produce such disruptive results. The crucial human issue facing rapidly growing communities is the stimulation of an environment that alleviates stress created or exacerbated by change. Even though a decrease in the rate of change has frequently been proposed as the most effective intervention mechanism, in the past this approach has not been implemented successfully, and may not be realistic for industry or completely controllable by the community. Whereas the primary human consequence of rapid community growth may be a disturbance in the network of support systems and the presence of barriers to the establishment of such systems, the most important variable in change management is the promotion and development of a positive sense of community. Two key approaches in this development process are the implementation of programs designed to promote community integration and techniques to reduce specific stress factors that accompany rapid change.

Community integration programs are designed to facilitate the development and use of informal support systems. Their primary goal is to alleviate the stress of change by reducing isolation from the community and increasing a sense of belonging. This is accomplished through the development of attitudes favoring reaching out to newcomers and engaging a cross section of residents in cooperative tasks geared to the enhancement of the community.

The design, implementation, and maintenance of a community integration program are most effectively accomplished by the local human resources planning body. Working under its leadership, and functioning as the backbone of the program, is a volunteer corps comprised of both current residents and newcomers recruited and supported by the human resources organization. The volunteers are trained in communication skills and in the recognition of common problems faced in moving to a new community. They have the responsibility for carrying out the two primary tasks of the program: preparing a community information handbook and identifying and contacting newcomers.

Because knowledge of support systems is often not institutionalized but rather is transmitted by word-of-mouth, newcomers have difficulty gaining the information they need about the community. A handbook that includes not only general information (maps, location, and telephone numbers of governmental and agency services), but that also heavily emphasizes personal resources (such as name and location of violin teachers, how to become a member of the volunteer fire department) can make this knowledge more immediately available. Information uniquely useful to people living in northwest Colorado for the first time, such as an appropriate winter wardrobe and high-altitude cooking techniques, can also be presented. In addition, the manual can include highlights of local history as described by the town's senior citizens.

A major function of the volunteer corps is to make a personal contact with each newcomer within a month of his arrival in the community. Newcomers are identified through information supplied by impacting industries, school districts, utility companies, churches, and responses to posters announcing the program. The volunteer provides a copy of the handbook, offers the new resident an opportunity to talk about living in the area, asks him about contacts he would like to make, and accompanies him to act as a bridge in making those contacts. The most important prevention components of this activity are the timeliness of the initial contact, and the active, ongoing personal interaction between the newcomer and the volunteer. The volunteer group itself can become a support system as many newcomers join and work together with the long-time residents toward shared goals.

Whereas the rapid influx of newcomers stresses communities and their support networks, these people also represent new resources to those communities. Several major corporations, including EXXON and AMAX, have created their own internal volunteer programs as a way of developing those human resources and making them available to meet local needs. Such programs facilitate the process of integration as they provide a sanctioned and ready link between the traditional community and the impacting industry.

Industry, with the assistance of the human resources planning body, can initiate other programs that are designed to reduce stereotyping of industry employees and to ease their transition into the community. For employees and their families, orientation programs covering practical considerations of living in the region (availability of services, recreation resources, transportation options, effect of geography) help reduce the stress of adjusting to the area. Presentation of public education programs on the plans for oil shale development to community groups and schools should include discussions of the work roles and tasks of the employees to help reduce the potential for negative stereotyping. Company policy, which encourages employees to participate in various community organizations and activities, can enhance these goals. For example, the disruptive components of change may be felt especially by law enforcement, social services, mental health agencies, and schools. Company employees on the boards of directors to volunteer services of these agencies can increase communication with the agencies and promote a cooperative approach to planning and problem resolution.

In addition to the concept of integration, a number of strategies can be adopted to reduce the overall level and impact of growth. Certain types of employment policies may lower the total number of newcomers and attract employees who have easier access to existing support networks and are more likely to remain in the community. Liberal nepotism policies can reduce the number of families moving into the area, create career alternatives for nonworking spouses, and increase the family's standard of living. The hiring of locals, when possible, and a "locals come home" program by which former residents are actively recruited to fill available jobs, increase the number of employees with ties to local support systems. Cooperative programs among industry, the local job service office, and local colleges, which identify the need for providing training in industrial and support job skills, promote the use of an existing labor pool of nonworking spouses and unskilled laborers. If successful, these efforts would lower the total number of newcomers needed to support the development and permit wider career options for residents of the community.

A major stress faced by a growing community is that of uncertainty about the actual changes planned or underway. Some residents tend to be skeptical, viewing industry-released information as self-serving or incomplete, and have trouble distinguishing between facts and speculation. The establishment of an unbiased information service provides residents with access to reliable and nonpolitical data. Examples of such neutral sources may be the League of Women Voters or the human resources planning organization.

An important consideration in the community's tolerance of growth is the impact of the construction phase of a project. If this stage is seen as socially disruptive, programs to integrate operations personnel and their families could be less effective and more difficult to implement. The hiring of as many long-term construction workers as possible increases the number of people who have an investment in becoming a part of the community. However, for short-term workers, integration into the community may not be a realistic or desirable goal. Provision of low-cost housing, longer work days with a shorter work week, and end-of-week travel back to their permanent homes may focus the workers' activities so that recreation and social needs are primarily met by their community of origin, thus reducing the impact on the growth community.

The effectiveness of these prevention programs is dependent not only on their success during each phase of development, but also on the outcome expected by the public. The most optimistic expectation would be the development and implementation of plans and programs that would keep the increase in identified problems at a level no higher than the actual rate of growth, while all sectors of the community work cooperatively toward the evolution of a socially satisfactory environment. At best, though, there may appear to be a disproportionate increase in problems during the early stages of development.

The initial increase is based on several realities of a community seeking equilibrium. As development approaches, extensive social disruption may be anticipated as inevitable. This is largely based on accounts of the experiences of earlier boom towns and tends to create an atmosphere conducive to a self-fulfilling prophecy. Additionally, newcomers have not yet developed reliable, trusted support systems, and may seek help through formal resources until those systems are in place.* Because the caregiver, the client, or both, are new to the community, no historical relationship exists, and the problem is less likely to be handled informally, thus producing a "case statistic." For example, although a rural law enforcement officer previously may have been able to handle a family dispute informally or to take a known alcoholic home or to a neighbor, the dynamics of a rapidly changing community tend to prohibit such informal settlements.

---

*Research currently being conducted by William Freudenburg (of Washington State University) at the Craig Office of the Colorado West Regional Mental Health Center, seems to indicate that the greatest increase in demand for mental health services did not come during the period of greatest growth. Rather, the demand appeared some two years later when the community's population total may have been stabilizing. Evaluating this observation in light of support systems theory is important, as no large-scale effort designed to act as a catalyst toward more immediate integration and stress reduction took place in that community.

Over the long run, the outlook can be more favorable because the rate of occurrence of social problems may fall below that of the predevelopment era. As has been suggested, a significant share of these problems in rural communities is related to isolation. For some of the long-time residents, participation in the community integration programs has the immediate effect of offering relief from the stress of isolation through structured group participation and a validated mechanism for approaching potential new acquaintances. Also, eventually there are likely to be more community amenities available than in the past because an enhanced economy and more favorable cost-benefit ratios may provide new commercial, educational, recreational, cultural, and social resources. In a stabilized, cohesive community, these resources may largely meet the individual needs of long-time resident and newcomer alike.

VIII. PLANNING AND NEEDS ASSESSMENT

In anticipation of large and rapid population growth, community needs and resources must be identified in a comprehensive and timely manner. Technical assistance must be obtained to support local planning efforts where expertise is lacking. Financial assistance must be sought. Attention to land use conflicts and development of comprehensive land use plans also are required to achieve desirable development patterns, minimize costs, and protect the social and physical environments. Adverse consequences of inefficient or poorly planned growth are numerous and often irreversible.

To meet the challenges of anticipated rapid growth, the state and local governments have initiated several mechanisms for planning and financing. Each incorporated municipality employs a full-time city manager. The towns of New Castle, Parachute, and DeBeque, for example, have jointly hired a town administrator circuit rider who assists in their growth management process. The counties, too, have planning directors and their staffs who report to the Board of County Commissioners. Comprehensive or master land use plans have been developed for Rio Blanco County and Garfield County; the plan for Mesa County was under development in 1980. A Garfield County housing study has been recently completed. Land use plans had been adopted by Craig, Dinosaur, Rangley, and Fruita and were under development for Meeker, Glenwood Springs, Silt, Rifle, Battlement Mesa, Palisade, and Grand Junction in 1980. In addition, Mesa County has compiled its land use regulations in preparation for their revision.

There are universal problems in developing and updating land use plans; for example, the constantly changing prospects for energy development and the uncertainty associated with industry plans. Also, large-scale oil shale development has been promised for this region for many decades and, consequently, there prevails a significant amount of doubt regarding the immediacy of rapid growth. Much of the planning effort, therefore, is focused on day-to-day problems, and comprehensive land use plans tend to consist of zoning ordinances and policy recommendations.

An impact analysis regulation, established by enabling legislation in 1977, provided another planning mechanism for all Colorado counties. The impact regulation requires a permitting process for the construction of any facility that would increase population by more than 1.25%. Thus far, only Rio Blanco County has implemented such legislation. In effect, this regulation gives the county authority not only to require an impact analysis by the developer, but also to require impact mitigation responsibilities to be undertaken by the developer as part of the construction permit. Modules on Federal lease tracts C-a and C-b were permitted through this process.

Recognition of the importance of identifying community needs, especially those requiring outside financial assistance, has prompted the development of county impact mitigation task forces. Variously organized into advisory and core committees, these task forces identify and evaluate problems and needs of the local communities. The most active task force is in Rio Blanco County. The members of the advisory committees are public officials, school officials, representatives of local interest groups, and citizens. The advisory committees submit applications to the core committees for consideration for Oil Shale Trust Fund appropriations. The members of the core committees represent several levels of government and industry, who determine the availability of resources to fund proposed projects and assign priorities to the projects according to a common set of criteria. Their recommendations are the basis of the Oil Shale Trust Fund request.[65] This process formalizes the interaction of government, industry, and private citizens in the growth management process and contributes to the refinement of needs assessment. This process also assures recognition of local values and is an early warning system for expected change. We believe the experience gained now will be invaluable for dealing with future crisis situations.

Planning activities at the regional level are sponsored by COG. On request, this council provides technical assistance, especially to small communities, in planning for growth. The COG also attempts to assist local communities in the area of grantsmanship and is represented on the county impact mitigation task force core committees. In general, the COG acts as a clearinghouse, compiling and providing information on the existing social and economic conditions, issues, and growth-related impacts. For example, the council recently compiled the results of a survey of municipal facilities and services in the region. The COG has developed a methodology for forecasting energy-induced population growth, the output of which includes population levels for each town in the four-county planning region. This growth monitoring system, a methodology for determining housing needs, and other planning tools are provided by the COG to the local planning groups.

At the state level, there is a concerted effort to prepare for energy-related growth impacts. The Division of Energy and Minerals in the Department of Local Affairs administers the Local Government Severance Tax Fund, the Local Government Mineral Lease Fund, and the Oil Shale Trust Fund appropriations, and in association with this role has developed an impact monitoring program. The Division maintains and periodically updates an inventory of community facilities, reviews Federal community grants and loan projects, assembles information on all energy and mineral development plans, and makes preliminary estimates of associated population impacts.[15] The Department of Local Affairs is in the process of collecting current data on public infrastructure throughout the state. Although most of the data are available, the state has never before assembled this information in one place. The Department of Natural Resources is in the process of developing an information system to predict population impacts, land use impacts, water requirements, and other environmental impacts implied by energy production plans in northwestern Colorado.[66]

There are several sources of state financing available for planning, design, site acquisition, construction, facility improvements, and programs. The Oil Shale Trust Fund appropriations, made annually by the Colorado Legislative Joint Budget Committee, have increased from $450 000 in 1975 to more than $15 million in 1980 (Tables XXVIII-XXXIV). Requests also are made to the Impact Assistance Advisory Committee, on whose advice the Local Government Mineral Lease and Severance Tax Funds are disbursed. The committee has

TABLE XXVIII

OIL SHALE LEASE FUND DISTRIBUTIONS IN FY75

Recipient	Appropriation
Meeker Schools	$ 4 000
Rio Blanco County Planning	10 000
Garfield RE-1	8 000
Garfield RE-2	12 389
Garfield County Planning	10 000
Mesa RE-51	42 575
Mesa RE-49JT	7 260
Mesa County Planning	10 000
Moffat RE-1	31 000
Colorado West COG	781
Office of Governor	
Administration	87 187
State Impact Report	92 734
TOTAL	$ 315 926

TABLE XXIX

OIL SHALE LEASE FUND DISTRIBUTIONS IN FY76

Recipient	Appropriation
Oil Shale Coordinator's Office	$ 100 000
Technical Assistance REgion XI COG	200 000
RE-51, Mesa	400 000
RE-49, Mesa	36 000
Roan Creek Road	467 595
DeBeque Bridge	299 658
RE-2, Garfield	1 000 000
RE-16, Garfield	121 057
RE-1, Garfield	200 000
Rulison Bridge	471 000
RE-1, Rio Blanco	1 189 000
RE-4, Rio Blanco	10 000
Piceance Creek Road	1 873 091
Bonanza Road	497 909
RE-1, Moffat	670 000
Hayden Streets	50 000
Routt County Road	100 000
Water Construction Fund-CWB	2 700 000
TOTAL	$10 385 310

TABLE XXX

OIL SHALE LEASE FUND DISTRIBUTION IN FY77

Recipient	Appropriation
Oil Shale Coordinator's Office	$ 106 000
Region XI COG	25 000
Delta County	17 000
Garfield County Planning	100 000
New Castle Sewer Planning	6 666
Silt Sewer Planning	6 666
Mesa RE-49	147 000
DeBeque Sewer	15 000
Road Creek Road	665 858
Craig Water Tank	215 000
Craig Hospital	230 000
RE-1 Moffat Leases	51 456
Mental Health	34 000
Rangely Sewer	460 000
Piceance Creek	2 135 000
Hayden School Site	25 000
TOTAL	$ 4 239 646

TABLE XXXI

OIL SHALE LEASE FUND DISTRIBUTION IN FY78

Recipient	Appropriation
Oil Shale Coordinator's Office	$ 114 079
Region XI COG Planning	62 500
Rangely Streets	500 000
Rangely Sewer	100 000
Meeker Streets	435 400
Meeker Hospital	30 000
Moffat County Bypass	250 000
Craig Drainage	25 000
Craig Water	125 000
Craig City Hall	275 000
Moffat-Sunset School	450 000
Moffat-Modular Rooms	74 000
Mental Health Center	95 857
Grand Valley Bridge	532 125
Garfield RE-2	273 757
Carbondale Sewer	479 000
Carbondale Mun. Building	75 000
Rifle Sewer	438 750
Rifle Lift Station	66 825
Rifle Planning	10 000
Silt Planning	6 500
Mesa RE-51	350 000
DeBeque Water	608 000
Roan Creek Road	135 000
Delta County Water	25 000
Hayden Water	280 000
Hayden Elementary School	450 000
Hayden Drainage	41 000
Hayden Recreation	20 000
Oak Creek Water	122 000
Walden Water	15 000
TOTAL	$ 6 464 793

TABLE XXXII

OIL SHALE LEASE FUND DISTRIBUTION IN FY79

Recipient	Appropriation
School Fund	$ 100 000
CWCB	600 000
Coordinator's Office	114 079
Rangely Streets	900 000
Meeker Streets	320 000
Meeker Pool	350 000
Meeker Sanitation	368 000
Impact Coordinator	17 500
Rangely Hospital	50 811
Colorado Northwest Community College	110 000
County Road 24	1 000 000
Garfield Airport	260 000
Rifle Water	2 056 000
Silt Water	151 000
Silt Planning	15 000
New Castle Water	196 000
Parachute Water	250 000
Rifle Bypass	500 000
Mesa County Sewer	104 450
Fruita Sewer	200 000
Mesa County Transportation	25 000
Mesa County Airport Water	293 250
Craig High School	750 000
Region XI Transportation	198 000
TOTAL	$ 8 929 090

TABLE XXXIII

OIL SHALE LEASE FUND DISTRIBUTION IN FY80

Recipient	Appropriation
Mesa County Sewer System Improvements	$ 796 787
BeBeque Water System Expansion and Improvements	300 000
Garfield County Silt Water Improvements	1 400 000
Parachute Sewage Treatment Plant	141 206
Rifle School Construction	2 750 220
Rifle Senior Center	172 500
Rifle Bypass	2 000 000
Rio Blanco County Meeker Streets and Drainage	800 000
C-a to Rangely Road Engineering	300 000
Meeker Sewage Treatment Expansion	1 440 000
Moffat County Dinosaur Water System	66 153
Oil Shale Coordinator's Office	63 056
Colorado West Area Council of Governments	16 040
TOTAL	$10 245 962

TABLE XXXIV

OIL SHALE LEASE FUND DISTRIBUTIONS IN FY81

Recipient	Appropriation
Division of Impact Assistance Administration	$ 97 020
Dinosaur Water System	146 250
Mesa County-Walker Field Improvements	3 960 000
Rifle Elementary School Facility	2 346 000
Rifle Drainage and Flood Plain Improvements	405 000
Silt Streets	1 300 000
Silt Elementary School	375 000
Rifle Senior Housing	440 000
Garfield County Airport	1 306 700
Rio Blanco County Gate Rangely Road	2 000 000
Meeker Water	684 000
Rangely Streets and Drainage	900 000
Meeker High School	1 187 000
TOTAL	$15 146 970

developed an extensive set of policies designed to maximize the limited financial resources by leveraging other sources of funds such as Federal grants and loans. Applicants are encouraged to exhaust all other potential sources of funding, including industry, to permit the impact fund to maintain a position of "last dollar in." Funds appropriated through this program for projects in the communities and counties examined in this report have exceeded $6 million over the past three years (Table XXXV). In addition to seeking external sources of funding, Mesa County has appropriated a substantial portion of its Payments in Lieu of Taxes funds for facilities' design (Table XXXVI).

As discussed above, preparation for the population growth induced by oil shale development and other energy and mineral development projects in this region depends on timely growth management activities including the evaluation of short-term and long-range needs and the identification and acquisition of available resources. Although all counties in Region 11 have initiated these processes, the uncertainty that surrounds oil shale development at this time has introduced a certain amount of skepticism with respect to its likelihood. The imminence of the "boom" has been promised repeatedly over several decades. The failure of the oil shale industry to develop as forecast in the mid-1970s belies the immediacy of oil shale development in this decade. As yet, there have been few signs of commitment from the Federal Government to guarantee a commercial oil shale industry of 300 000 bbl/day, one million bbl/day, or

TABLE XXXV

LOCAL GOVERNMENT MINERAL LEASE AND SEVERANCE TAX FUND APPROPRIATIONS

Impact Number	Project	Request	Granted
Mesa County			
78-0049	Mesa District Ambulance	25 000	$ 0
78-0075	County Emergency Medical Service	50 000	0
78-0158	County Road E Realignment	98 000	65 000
79-0195	Air Monitoring	40 664	25 000
80-0333	College Center	150 000	0
			90 000
DeBeque			
78-0090	School District #49 Joint Planning Project for Future School Site	62 600	7 600
78-0169	Schools	68 810	68 810
79-0261	Senior Center	11 496	11 496
80-0314	Ambulance	withdrawn	
80-0368	Sewer Plant	72 000 +20 700 loan	92 700
80-0358	DeBeque/Collbran Circuit Rider City Manager	32 610	32 610
			213 216
Fruita			
78-0156	City of Fruita Water Systems Improvements (grant/loan)	77 500	77 500
80-0302	Park	15 000	15 000
80-0375	Housing Rehabilitation	180 000	pending
			92 500
Grand Junction			
80-0376	Senior Housing	80 200	80 200
Palisade			
78-0168	Water Improvements	60 000	18 600
Garfield County			
78-0108	County Bridge	83 000	83 000
78-0112	Garfield SD RE-2 Site Acquisition School Design and Master Plan	140 000	30 000
79-0194	Comprehensive Plan	43 000	43 000
80-0267	Training Center	150 000	150 000
80-0301	Counselors	47 442	47 442
80-0328	Youth Services II	18 075	0
80-0336	County Airport	withdrawn	
80-0343	Community Human Services	172 118	172 118
			525 560
Glenwood Springs			
79-0236	Youth House	25 900	23 542
80-0331	Comprehensive Plan	21 252	21 252
80-0377	Fire Truck	80 000	0
			44 794

TABLE XXXV (cont)

LOCAL GOVERNMENT MINERAL LEASE AND SEVERANCE TAX FUND APPROPRIATIONS

Impact Number	Project	Request	Granted
New Castle			
80-0277	New Castle Water	28 000	28 000
80-0369	New Castle Water II	200 000	200 000
80-0358	New Castle/Parachute Circuit Rider City Manager	33 973	33 973
			261 973
Parachute			
78-0084	County School District #16 Community Park	82 580	0
79-0121	Central Grand Valley Sanitation District Sewer Line	175 000	0
79-0222	Boys Club	52 200	0
80-0370	Water Plant	270 000	270 000
80-0371	Sewer	200 000	200 000
			470 000
Rifle			
78-0073	School/Community Liaison Officer for Crime Prevention	24 015	0
78-0097	Core Commercial Design Study	38 500	10 000
78-0111	Job Service Center Office Space	8 400	8 400
79-0208	Senior Center	57 500	57 500
79-0209	Comprehensive Plan	65 000	50 000
79-0210	Tennis Courts	40 000	0
79-0247	Youth Services	26 458	26 458
79-0230	Firehouse and Pumper	93 500	45 000
80-0308	Housing Site	90 750	90 750
80-0323	City Hall Remodeling	459 575	0
80-0332	High School Conversion	42 144	42 000
80-0334	Hospital Upgrade	191 000	191 000
80-0381	Police Communications	8 392	deferred
80-0383	Police Staff	30 822	30 822
			551 930
Silt			
78-0081	Community Building Project	15 000	15 000
78-0082	Town Administration Program	34 800	20 000
79-0110	Silt/New Castle Fire District Housing for Fire Department	21 000	21 000
79-0251	Sewer Design	28 350	28 350
79-0252	Town Administrator	18 000	18 000
79-0253	Comprehensive Plan III	14 000	14 000
			116 350

TABLE XXXV (cont)

LOCAL GOVERNMENT MINERAL LEASE AND SEVERANCE TAX FUND APPROPRIATIONS

Impact Number	Project	Request	Granted
Moffat County			
78-0036	County Detoxification Center	50 000	50 000
78-0037	County Road and Bridge	255 000	80 000
78-0040	County Memorial Hospital Equipment	76 000	28 000
78-0044	County High School	750 000	250 000
78-0145	County First Street Right-of-Way Phase II	86 450	86 450
78-0146	Crisis Intervention Team	38 850	30 850
78-0150	Memorial Hospital Construction	170 000	170 000
79-0223	Mental Health III	30 000	30 000
80-0296	County Ambulance	40 000	40 000
80-0297	County Mental Health III	32 100	32 100
			797 400
Craig			
78-0035	City/County Park	180 000	180 000
78-0038	Craig Maintenance Garage and Equipment	150 000	100 000
78-0039	Craig/Moffat County Library	400 000	6 000
78-0041	Mental Health Center	37 400	37 400
78-0042	Craig/Moffat County Airport	25 000	0
78-0144	Wastewater Expansion Treatment Facility	162 500	162 500
78-0151	Land Fill Compactor	41 200	0
78-0173	Parks and Recreation	35 000	35 000
79-0221	Library	250 000	150 000
79-0225	Elementary School	750 000	200 000
80-0288	Water	2 000 000	1 000 000
			1 870 900
Rio Blanco County			
78-0103	Fire Protection District Equipment	161 559	67 000
78-0237	Technical Assistance	20 000	0
80-0291	Rio Blanco Hospital Severance Tax Prepayment	approved	40 000
80-0293	County Road #5	112 166	112 166
			219 166
Meeker			
78-0025	Design--Meeker School Expansion	76 387	76 387
79-0026	Bus Storage Facility	42 600	0
78-0153	Job Service Center	7 480	0
79-0203	Foothills Park	24 000	16 000
79-0220	Hospital Remodeling	156 000	130 000
79-0240	Library Equipment	7 000	7 000
80-0266	Sewer	144 000	144 000
80-0285	Meeker/Rifle Job Service	80 000	80 000
80-0294	Housing-601 Match	67 000	67 000
80-0386	Meeker/Rangely Compactors	170 683	170 700
			691 087

TABLE XXXV (cont)

LOCAL GOVERNMENT MINERAL LEASE AND SEVERANCE TAX FUND APPROPRIATIONS

Impact Number	Project	Request	Granted
Rangely			
78-0068	District Hospital Planning and Equipment Program	46 950	20 000
78-0096	Housing Proposal	44 000	44 000
78-0099	Town Special Projects Coordinator	18 166	0
78-0102	Colorado Northwest Community College Instrumentation Technology Program	76 553	20 000
78-0105	Northwest Colorado Mental Health Service	26 405	7 465
79-0205	Communications Center	5 000	0
79-0243	Day Care	12 500	0
80-0265	Mental Health	15 412	0
80-0290	Water	75 000	75 000
80-0326	Animal Shelter	withdrawn	
			166 465
Region			
78-0125	Mesa College Vocational Training Program	39 400	33 900
78-0166	Eastern Garfield County Regional Transportation Plan Region II Council of Governments	19 600	19 600
79-0186	Western Colorado Environmental Monitor	34 000	34 000
79-0192	Northwestern Colorado Council of Governments Impact Assistance	18 835	18 835
79-0227	Circuit Rider City Manager Program DeBeque, Parachute, New Castle	---	31 000
80-0280	Routt/Moffat New Baby Visits	20 000	20 000
80-0286	Region II Impact Technical Assistance	37 816	37 816
80-0337	Western Colorado Health Systems Agency	100 000	100 000
80-0340	Region II 601 Planning Impact Match	15 000	15 000
			310 151
	TOTAL		$6 520 292

SOURCE: Fourth Annual Report to the Colorado State Legislature 1981, Colorado Department of Local Affairs, Division of Impact Assistance, January 1981.

TABLE XXXVI

MESA COUNTY, COLORADO,
PAYMENT IN LIEU OF TAXES BUDGET FOR 1980

Urban Area Drainage Plan and Design	$ 90 000
F Road (Old Patterson Road) Design	114 000
Horizon Drive Design	100 000
Goat Draw Arterial Design and Right-of-Way	250 000
Bike Path Design and Construction (2-1/2 miles long)	152 000
Parks Development	75 000
Dust Control	100 000
Veterns Park Swimming Pool Design and Construction	170 000
Sheriff's Department Plane--Purchase	69 000
Distribution into Various County Department Budgets	410 000
Contingency	27 905
Total Amount Available and Budgeted	$1 557 905

eight million bbl/day. Consequently the urgency of planning for any such industry is somewhat diminished and local governments have found it difficult to demonstrate the need for impact assistance.

IX. CONCLUSIONS

Accommodating the large influx of population accompanying oil shale development in the Piceance Basin and general energy development in the region will present enormous challenges to the existing communities. The construction and operation work force requirements of a 300 000 bbl/day oil shale industry nearly equal the total existing labor force in Rio Blanco and Garfield Counties. There are no large urban areas in the region in which the existing infrastructure and support systems could readily absorb the anticipated poplation impact. The largest community, Grand Junction, already suffers from growth rates that strain existing support systems. The development of a commercial oil shale industry will require a far greater expansion of existing facilities and provision of utilities, housing, schools, health, and social services than "normal" growth (nonenergy-related growth) would have required.

In anticipation of the promised energy development, many communities in northwestern Colorado have expanded public facilities, specifically water treatment plants, sewer systems, and schools through state and Federal financial assistance. Excess capacity in these facilities is expected to minimize disruption of services and to alleviate the immediate impacts of rapid population growth. The construction of the new town of Battlement Mesa is expected to further reduce financial pressures on local governments. During the initial phase of the population impact, the community resource requirements are greatest, especially for construction of expensive public facilities. The tax base generated by new industrial and population growth falls behind, by several years, the time of greatest revenue needs; therefore, long-range fiscal planning is required of local governments to bridge the revenue gap. Jurisdictional mismatches and state regulations further complicate the fiscal problem. All of the Colorado oil shale facilities are planned for remote areas of Garfield and Rio Blanco Counties; the greatest population impacts are expected to occur in Garfield County. Furthermore, substantial increased demand for retail, professional, and transportation services is expected in Grand Junction, located in adjacent Mesa County. Comprehensive fiscal planning will require local, state and Federal Governments to evaluate impacts and interaction of alternative fiscal policies for this multijurisdictional region.

Supply of adequate housing probably will require intervention from industry and/or state and Federal Government. Perception of risk may delay construction of housing until demand exists, thereby reproducing the unpleasant experiences of other energy-impacted communities if the development of the oil shale industry is successful. With the exception of industry-financed Battlement Mesa developments, planned housing in the oil shale region is expected to accommodate only existing demand.

State and local planners have placed increased emphasis on the need to provide human services and community support facilities. The experiences of other boom towns in the Rocky Mountain Region have clearly demonstrated the need for early implementation of programs designed to minimize the severity of social impacts. These programs require careful planning, extensive coordination among various agencies and groups, and accurate monitoring and assessment of social changes.

Much attention has been focused on the need to promote community goals, to maintain a sense of community, and to preserve the quality of life that exists in the region. To do so, community needs must be identified in a comprehensive and timely manner. County impact mitigation task forces have great potential as mechanisms for coordinating local participation in this planning process. The task force in Rio Blanco County is the most active of the region.

In sum, the adverse impacts of oil shale development cannot be prevented without early identification of community needs. Comprehensive fiscal and land use planning are required to achieve desirable development patterns, to select equitable and effective fiscal policies, and to protect the social and physical environments. Adverse consequences of inefficient or poorly planned growth are numerous and often irreversible. Because oil shale development has been promised for so many years, however, its likelihood is viewed with much skepticism in the region at this time. This attitude has reduced the perceived urgency to develop comprehensive growth management plans. In addition, the constantly changing schedules and magnitudes of oil shale development defy timely implementation of plans.

ACKNOWLEDGMENTS

We would like to thank the project monitors, Arnold Goldberg and George Rotariu, (US Department of Energy), and the project managers, Darryl Hessel and Ira Levy, (Pacific Northwest Laboratory). We would also like to thank Don Morris, John Jaksch, and Andy Ford for their time and very helpful comments in reviewing all or portions of this report. We are especially grateful for the technical editing of Betsy Ronquillo and Lucille Schilling, the typing of Grace Roybal, Jean Martinez, and Ann Nagy, and the support of Dale Spall.

In addition, we thank the many members of Colorado's State and local governments who contributed their time and assistance so generously. In particular, we would like to acknowledge Maxine Albers, Ray Baldwin, Steve Colby, Bob Demos, Bob Ekland, Walt Hecox, John Johnson, Mike Kelly, Connie McDonnough, Mike McGrane, Duane Rehborg, Steve Schmitz, and Kay Weisbecker.

REFERENCES

1. F. A. Ford, "Social and Economic Impacts," in "National Coal Utilization Assessment. The Impacts of Increased Coal Use in the Rocky Mountain Region," Los Alamos National Laboratory internal document S-2:F8-2, Draft, 1978.

2. D. S. Stinson and M. O'Hare, "Predicting the Local Impacts of Energy Development: A Critical Guide to Forecasting Methods and Models," prepared by the Laboratory of Architecture and Planning, Massachusetts Institute of Technology, under Energy Research and Development contract No. E (49-18)-2295, May 1977.

3. D. Spilton, D. Solomon, J. Evaul, and R. Takai, "Data Base Development and Data Analysis," in "Suggestions For An Enhanced Socioeconomic Information Capability in the Bureau of Land Management," prepared by the Center for Demographic Studies, US Bureau of the Census, for the Bureau of Land Management, US Department of the Interior (April 1980).

4. "Evaluation of Selected Community Needs," McDowell-Smith and Associates, 1982 Highway 13, Rifle, Colorado, 81650 (August 1975).

5. "Development Patterns and Social Impacts: A Focus on the Oil Shale Region," Quality Development Associates, Inc., Denver, Colorado (July 1979).

6. "Socioeconomic Impacts of Western Energy Resource Development. Vol. II: Assessment Methodologies," Denver Research Institute and Resource Planning Associates, sponsored by the President's Council on Environmental Quality, the Department of the Interior, US Geological Survey, US Environmental Protection Agency, Department of Energy, and the National Science Foundation, Washington, DC (June 1979).

7. A. R. Markusen, "Socioeconomic Impact Models for Boom Town Planning and Policy Evaluation," Western Regional Science Association Meeting, Sacramento, California, February 25, 1978.

8. C. F. Cortese and J. A. Cortese, The Social Effects of Energy Boom Towns in the West: An Annotated Bibliography (June 1978).

9. C. Cluett, M. Greene, and L. Radford, "Individual and Community Response to Energy Facility Siting: A Review of the Literature," Battelle Human Affairs Research Centers report B-HARC-411-045 (November 1979).

10. D. A. Rapp, "IMPACT, An Assessment of the Impact of Oil Shale Development--Colorado Planning and Management Region 11," Vol. I-V, Office of the Governor, Oil Shale Planning and Coordination, Denver, Colorado (December 1974).

11. R. Rink and A. Ford, "A Simulation Model for Boom Town Housing," Los Alamos National Laboratory report LA-7324-MS (September 1978).

12. "Colorado Manpower Review," Vol. XVII, No. 5, prepared by the Labor Market Information Branch of the Colorado Department of Labor and Employment, Division of Employment and Training, 251 East Twelfth Ave., Denver, Colorado, 80203 (May 1980).

13. L. C. Gould, "Social Science Research on 'The Energy Boom Town'," Social Science Energy Review 1, No. 1, 8-30 (Winter 1978).

14. "Colorado Manpower Review," Vol. XVII, No. 3, prepared by the Labor Market Information Branch of the Colorado Department of Labor and Employment, Division of Employment and Training, 251 East Twelfth Ave., Denver, Colorado, 80203 (March 1980).

15. "Third Annual Report to the Colorado Legislature 1980, Summary and Status Report of the Mineral Lease and Severance Tax Fund," Colorado Department of Local Affairs, Division of Energy and Mineral Impact, Denver, Colorado (January 1980).

16. "Energy Development Population Scenarios by County," Colorado Department of Local Affairs, Division of Energy and Mineral Impact (November 23, 1979).

17. "Colorado Oil Shale: The Current Status," prepared by the Department of Natural Resources, State of Colorado, for the US Department of Energy, Oak Ridge report DOE/TIC-10251 (October 1979).

18. Colorado West Area Council of Governments' 1980 Regional Population Projections Growth Monitoring Report (November 26, 1979).

19. "Socioeconomic Impacts of Western Energy Resource Development. Vol. III: Case Studies," Denver Research Institute and Resource Planning Associates, sponsored by the President's Council on Environmental Quality, the Department of the Interior, US Geological Survey, US Environmental Protection Agency, Department of Energy, and the National Science Foundation, Washington, DC (June 1979).

20. "Oil Shale Tract C-b Socio-Economic Assessments: Vol. II Impact Analysis," C-b Shale Oil Project, Ashland Oil, Inc., Shell Oil Co. Operator (March 1976).

21. "Addendum to the Social and Economic Impact Statement of March 1976," Rio Blanco Oil Shale Project, Gulf Oil Corporation and Standard Oil Company of Indiana (May 1977).

22. "Cathedral Bluffs Shale Oil Project Socioeconomic Monitoring Report, Number 6," Quality Development Associates, Inc., Denver, Colorado (1979).

23. "The Costs of Sprawl," Real Estate Research Corporation, prepared for the President's Council on Environmental Quality, Washington, DC (April 1974).

24. "Impact Analysis and Development Patterns for the Oil Shale Region: Mesa, Garfield, and Rio Blanco Counties, Colorado," Colorado West Area Council of Governments and the Oil Shale Regional Planning Commission, Denver, Colorado (February 1974).

25. N. L. Dalsted, A. G. Leholm, N. E. Toman, R. C. Coon, T. A. Hertsgaard, and F. L. Leistritz, "Economic Effects," Chapter 5 of "Environmental, Economic and Social Impacts of a Coal Gasification Plant in Western North Dakota," compiled by F. L. Leistritz and T. A. Hertsgaard, North Dakota Agricultural Experiment Station Bulletin No. 509, North Dakota State University (February 1980).

26. "Construction Worker Profile," prepared by Mountain West Research, Inc., for the Old West Regional Commission, Washington, DC (December 1975).

27. S. Goldstein, Colorado Demographer's Office, personal communication, February 19, 1980.

28. D. A. Rapp, "Uranium Mining and Milling Work Force Characteristics in the Western United States," Los Alamos National Laboratory report LA-8656-MS (December 1980).

29. J. Gilmore and M. Duff, "A Growth Management Case Study: Sweetwater County, Wyoming," University of Denver Research Institute, Denver, Colorado (December 1974); also available as Boom Town Management (Westview Press, Park, Colorado, November 1975).

30. C. F. Cortese and B. Jones, "The Sociological Analysis of Boom Towns," in Boom Towns and Human Services, J. A. Davenport and J. Davenport, III, Eds. (The University of Wyoming, Laramie, 1979).

31. E. J. Stenehjem, "Summary Description of SEAM: The Social and Economic Assessment Model," Argonne National Laboratory report ANL/IAPE-TM-78-9 (April 1978).

32. "The Costs of Sprawl," prepared by Real Estate Research Corporation for the President's Council on Environmental Quality, Washington, DC (April 1974), p. 6.

33. "Socioeconomic Impacts of Western Energy Resource Development. Vol. II: Assessment Methdologies," Denver Research Institute and Resource Planning Associates, sponsored by the President's Council on Environmental Quality, the Department of the Interior, US Geological Survey, US Environmental Protection Agency, Department of Energy, and the National Science Foundation, Washington, DC (June 1979), p. 76.

34. "Socioeconomic Impacts of Western Energy Resource Development. Vol. III: Case Studies," Denver Research Institute and Resource Planning Associates, sponsored by the President's Council on Environmental Quality, the Department of the Interior, US Geological Survey, US Environmental Protection Agency, Department of Energy, and the National Science Foundation, Washington, DC (June 1979), p. 118.

35. "Fourth Annual Report to the Colorado State Legislature 1981, Summary and Status Report of the Mineral Lease and Severance Tax Fund," Colorado Department of Local Affairs, Division of Impact Assistance, Denver, Colorado (January 1981).

36. D. J. Santini, E. J. Stenehjem, and P. Meguire, "Methods of Eliminating Potential Socioeconomic Constraints on Near-Term Coal-Energy Development," Argonne National Laboratory report ANL/EES-TM-47 (April 1978).

37. William Lamont, Study Team Director, "Tax Lead Time Study for the Oil Shale Region," prepared for the Regional Development and Land Use Planning Subcommittee of the Governor's Committee on Oil Shale Environmental Problems and available through Colorado Geological Survey, Department of Natural Resources, State of Colorado, Denver, Colorado (1974).

38. R. M. Bolt, D. Luna, and L. A. Watkins, "Boom Town Financing Study, Vol. I. Analysis and Recommendations," Colorado Department of Local Affairs, Denver, Colorado (November 1976).

39. "Socioeconomic Impacts of Western Energy Resource Development. Vol. II: Assessment Methodologies," Denver Research Institute and Resource Planning Associates sponsored by the President's Council on Environmental Quality, the Department of the Interior, US Geological Survey, US Environmental Protection Agency, Department of Energy, and the National Science Foundation, Washington, DC (June 1979), p. 79.

40. R. L. Ekland and M. E. McGrane, "Local Government Fiscal Capacity Evaluation System, Executive Summary," Colorado Department of Local Affairs, Division of Local Government, Denver, Colorado (May 1977).

41. H. Lee, "Oil Shale Development: A Perspective on Certain Regional Economic Issues," Energy and Environmental Policy Center, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts (September 1980).

42. J. S. Gilmore, "Boom Towns May Hinder Energy Resource Development," Science 191, 4227, 535-540 (February 13, 1976).

43. "Synthetic Liquid Fuels Development: Assessment of Critical Factors. Vol. III Regionalized Industry, Social Impact, Coal Resource Depletion," Energy Research and Development Administration report ERDA 76-129/3 (May 1977).

44. A. B. Crawford, H. H. Fullerton, and W. C. Lewis, "Socio-Economic Impact Study of Oil Shale Development in the Uintah Basin," Western Environmental Associates, Inc., Providence, Utah (November 1975).

45. "Construction Worker Profile Summary Report," Prepared by Mountain West Research, Inc., for the Old West Regional Commission, Washington, DC (December 1975), pp. 13-15.

46. "Socioeconomic Impacts of Western Energy Resource Development. Vol. III: Case Studies," Denver Research Institute and Resource Planning Associates, sponsored by the President's Council on Environmental Quality, the Department of the Interior, US Geological Survey, US Environmental Protection Agency, Department of Energy, and the National Science Foundation, Washington, DC (June 1979), pp. 120-121.

47. Ibid, p. 123.

48. R. Rink and A. Ford, "A Simulation Model for Boom Town Housing," Los Alamos National Laboratory report LA-7324-MS (September 1978), p. 40.

49. R. Baldwin, Garfield County Planning Director, Glenwood Springs, Colorado, personal communication, February 29, 1980.

50. "Cathedral Bluffs Shale Oil Project Socioeconomic Monitoring Report, Number 5," Quality Development Assoicates, Inc., Denver, Colorado (August 1979).

51. J. L. Ballagh, Armstrong Engineers and Associates, Inc., Grand Junction, Colorado, personal communication, February 25, 1980.

52. A. Lantz, K. Sackett, and J. Halpern, "Alcohol-Related Problems in Rapidly Growing Communities," in The Boom Town: Problems and Promises in the Energy Vortex, J. Davenport, III, and J. A. Davenport, Eds. (The University of Wyoming, Laramie, 1980).

53. A. Lantz and R. L. McKeown, "Social/Psychological Problems of Women and Their Families Associated with Rapid Growth," in Energy Resource Development: Implications for Women and Minorities in the Intermountain West (US Commission on Civil Rights, Washington, DC, 1979).

54. E. Moen, "Social Problems in Energy Boom Towns and the Role of Women in Their Prevention and Mitigation," in The Boom Town: Problems and Promises in the Energy Vortex, J. Davenport, III and J. A. Davenport, Eds. (The University of Wyoming, Laramie, 1980).

55. S. S. Larson, "The Elderly: Victims of the Energy Venture," in The Boom Town: Problems and Promises in the Energy Vortex, J. Davenport, III and J. A. Davenport, Eds. (The University of Wyoming, Laramie, 1980).

56. C. L. Guillaume and S. R. Wenston, "Child Abuse in Impact Communities," in The Boom Town: Problems and Promises in the Energy Vortex, J. Davenport, III, and J. A. Davenport, Eds. (The University of Wyoming, Laramie, 1980).

57. B. L. Purrington, "Revitalizing Rural Cultures: A Case for the Development of Rural Ethnicity," in Planning Frontiers in Rural America (US Government Printing Office, Washington, DC, 1976).

58. P. Holmes and R. Rahe, "Social Readjustment Rating Scale," in Stressful Life Events, B. S. Dohrenwend and B. T. Dohrenwend, Eds. (John Wiley and Sons, New York, 1974).

59. National Institute of Mental Health, A Model for Estimating Mental Health Needs Using 1970 Census Socioeconomic Data (US Government Printing Office, Washington DC, 1974).

60. R. Weisz, "Stress and Mental Health in a Boom Town," in Boom Towns and Human Services, J. A. Davenport and J. Davenport, III, Eds. (The University of Wyoming, Laramie, 1979).

61. S. Cobb, "Social Support as a Moderator of Life Stress," in Psychosomatic Medicine 38, 300-314 (1976).

62. J. Kassover and R. L. McKeown, "Toward a Sense of Community in the Modern Boom Town," Colorado West Regional Mental Health Center, Inc., Glenwood Springs, Colorado (1979).

63. G. Caplan, Support Systems and Community Mental Health (Behaviorial Publications, New York, 1974).

64. M. Hoagland, "A New Day in Rural Mental Health Services," from a series New Dimensions in Mental Health (National Institute of Mental Health, Rockville, MD, 1978).

65. "1980 Oil Shale Trust Fund Request," Colorado West Area Council of Governments, Rifle, Colorado (November 1979).

66. W. E. Hecox, "Colorado Energy Resource Development Plan: A Decision Assistance Tool," Conference on Computer Models and Forecasting Impacts of Growth Management, Alberta, Canada, April 20-23, 1980.

DISTRIBUTION

No. of
Copies

OFFSITE

A. A. Churm
DOE Patent Division
9800 South Cass Avenue
Argonne, IL 69439

2 DOE Technical Information Center

H. Ash
U.S. Department of the Interior
Building 67, Room 820-A
Denver Federal Center
Denver, CO 80225

K. L. Berry
Rio Blanco Oil Shale Company
9725 E. Hampden Avenue
Denver, CO 80231

G. Bierman
Science Applications, Inc.
1710 Goodridge Drive
McLean, VA 22102

A. C. Bishard
Colorado Department of Health
4210 E. 11th Ave.
Denver, CO 80220

W. R. Chappell
University of Colorado
P.O. Box 136
Denver, CO 80202

J. A. Coleman
Office of Environmental
Assessments
Mail Stop E-201/Germantown
Washington, DC 20545

No. of
Copies

R. Cooper
Office of Health and
Environmental Research
U.S. Department of Energy
Washington, DC 20545

Mark Ethridge
American Petroleum Institute
Policy Analysis Group
2101 L Street, N.W.
Washington, D.C. 20037

P. Fox
1988 California Street
Berkeley, CA 94705

L. Habeggar
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

B. Harney
Office of Shale Resource
Applications
Technology Assessments Division
U.S. Department of Energy
Washington, DC 20545

R. Heistand
Development Engineering, Inc.
Box A
Anvil Point
Rifle, CO 81650

L. M. Holland
Los Alamos National Laboratory
P.O. Box 1663
Los Alamos, NM 87545

No. of Copies		No. of Copies	
	P. W. House Office of Environmental Assessments U.S. Department of Energy Washington, DC 20545		A. Rudolph Battelle Memorial Institute 505 King Avenue Columbus, OH 43201
	R. K. Lohrding Los Alamos National Laboratory P.O. Box 1663 Los Alamos, NM 87544		R. D. Shull Regional Impacts Division Mail Stop E-201/Germantown U.S. Department of Energy Washington, DC 20545
	C. Mangeng Los Alamos National Laboratory P.O. Box 1663 Los Alamos, NM 87545		W. E. Siri Lawrence Berkeley Laboratory University of California Berkeley, CA 94720
	D. Mastbaum Environmental Defense Fund 2606 Dwight Way Berkeley, CA 94704		G. Strasser Strasser Associates, Inc. 2616 Pine Knot Drive Vienna, VA 22180
	J. Merino TOSCO P.O. Box 814 Vernal, UT 84078		T. Surles Argonne National Laboratory 9700 South Cass Avenue Argonne, IL 60439
	G. Miller U.S. Geological Survey-AOSO 131 No. 6th, Suite 300 Grand Junction, CO 81501		T. Thoem Office of Energy, Region VII Environmental Protection Agency 1860 Lincoln Denver, CO 80295
	D. M. Monti Technology Assessments Division Mail Stop E-201/Germantown U.S. Department of Energy Washington, DC 20545		R. E. Thomason Occidental Oil Shale, Inc. P.O. Box 2999 Grand Junction, CO 81501
	E. M. Piper Energy Development Consultants 2221 East Street Golden, CO 80401		M. F. Torpy Argonne National Laboratory 9700 South Cass Avenue Argonne, IL 60439
35	G. J. Rotariu Technology Assessments Division Mail Stop E-201/Germantown U.S. Department of Energy Washington, DC 20545		J. W. Skiles Department of Range Science Colorado State University Ft. Collins, CO 80523

No. of
Copies

E. R. Williams
Regulatory Analysis Division
Mail Stop E-201/Germantown
U.S. Department of Energy
Washington, DC 20545

ONSITE

DOE Richland Operations Office

H. E. Ransom

35 Pacific Northwest Laboratory

W. J. Bair
D. L. Brenchley
D. C. Cearlock

No. of
Copies

K. R. Chase
R. L. Drake
H. Drucker
C. E. Elderkin
J. S. Fruchter
I. D. Hays
D. L. Hessel
I. S. Levy
B. W. Mercer
S. Marks (10)
J. M. Nielsen
B. E. Vaughan
R. E. Wildung
J. N. Zachara
Technical Information Library (3)
Publishing Coordination (KC)(2)
Economics Library (5)